Division of Agricultural Sciences
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GUIDES TO PROFITABLE CROPPING SYSTEMS FOR YOLO COUNTY FARMS

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CALIFORNIA AGRICULTURAL EXPERIMENT STATION
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The authors wish to acknowledge the cooperation of the Yolo County farmers who participated in a 1959 farm survey and who provided much of the basic data used in this study. Valuable advice and assistance were also received from Mr. M. P. Zobel and Mr. T. S. Torngren of the Yolo County Farm Advisor's Office, Dr. Milton D. Miller and Mr. Jack Hills of Agronomy Extension, Dr. John Lingle of Vegetable Crops, Mr. Don Deter of Spreckles Sugar Company in Woodland, and Dr. Doyle Reed and Mr. Phillip Parsons of Agricultural Economics Extension. The linear programming calculations were performed in the Agricultural Economics Statistical Pool under the supervision of Mrs. Marilyn Vaage.

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SUMMARY AND CONCLUSIONS

In recent years the costs of labor and other farm inputs have increased. Simultaneously, product prices have generally remained steady or declined, resulting in downward pressure on farm incomes. Thus farmers are constantly seeking new and improved techniques to increase crop production efficiency. In addition, farmers face the problem of integrating or coordinating different parts of their business into a profitable overall operation.

This study concentrates on the coordination aspects of the farm management problem. That is, assuming efficient techniques for producing each crop, the primary problem is one of selecting the "best" or "most profitable" cropping system for farmers in a number of different resource situations. The results are applicable mainly to the relatively homogeneous cash crop farming area around Woodland in Yolo County, California. However, sound farm management principles are illustrated with these data that should be useful to farmers in other areas. Within the Yolo County area, "typical" farm situations are defined on the basis of farm size, soil type, machinery, operating capital, acreage allotments, rental contracts and other factors. For each situation the "optimum" or "most profitable" cropping system is selected from among the many crop alternatives available. Linear programming--an advanced form of farm budgeting--is used in selecting optimum cropping plans.

Based on a 1959 survey of farms in the Woodland area, farms of four typical sizes were defined: 225 acres, 480 acres, 820 acres and 1,500 acres. A machinery complement typical of each acreage size also was selected. Based on linear programming, "most profitable"

cropping systems were developed for each farm size under two alternative assumptions: (1) Acreage fixed and operated under usual tenure arrangement for farms of that size; (2) machinery fixed but with additional land rented and the operation expanded until machinery capacity limited further expansion.

Detailed findings of the study are available in the charts and text of the report. Briefly, some of the main results are as follows:

(1) Optimum cropping plans depend directly on the amount of operating capital employed: The optimum (most profitable) plan for a beginning farmer with limited funds is quite different from the optimum plan for an established operator with ample operating capital, even when both farmers have the same amount of land, machinery and other resources. The operator with limited capital maximizes profit by selecting crops with the highest return <u>per dollar of operating capital</u>, even though other crops may give greater returns <u>per acre</u>. Thus, farmers in this position usually lease or sublease tomatoes to another farmer, and concentrate on crops like barley, wheat and others giving high returns on their limited capital. Farmers with higher levels of operating capital can profitably intensify the cropping system by raising their own tomatoes and concentrating on relatively high income per acre crops such as sugar beets, sudan grass seed and alfalfa.

(2) With a given machinery complement and operating capital level, greater profits are possible with an extensive operation (renting more land and planting crops with high returns on operating capital) than an intensive operation (planting high income per acre crops on a more limited acreage).

(3) Many farms in the area are over-mechanized and could increase profits either by (a) operating additional land to "spread" machinery fixed costs over more units of output or by (b) reducing machinery

cropping systems were considered [illegible] with [illegible] assumptions: (1) Although fixed and variable costs [illegible] only for typical [illegible]; (2) [illegible] land rented out [illegible] costs [illegible] expected until [illegible] lower expenses.

Detailed findings of the study [illegible] of the report. [illegible], some of the more [illegible] below.

(1) Cotton [illegible] farms [illegible] Alternatives to [illegible] cotton [illegible] profitability [illegible] [illegible] land in [illegible] [illegible] [illegible] [illegible] for [illegible] the same amount of land [illegible]. [illegible] with limited capital [illegible] with the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] crops like [illegible], [illegible] and [illegible], [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] such as hogs, cattle, dairy goats and poultry.

(2) [illegible] enterprises.

(3) [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of crops [illegible] [illegible]

investment to a level more consistent with the size of operation. While some excess machinery is probably desirable as a safety measure in case of breakdowns or in periods of unfavorable weather, some farmers in the Woodland area have machinery capacity far in excess of that required merely for "insurance."

(4) A 225-acre Woodland farm, as usually organized and mechanized, is in a vulnerable position economically. Even with adequate operating capital and farmed to intensive crops, the operation generally is not sufficiently large to return a market rate of interest on land and machinery investment plus a satisfactory operator income. However, if the machinery generally owned by the smaller farmers is used to near capacity by renting additional land, satisfactory income levels are possible.

(5) A 480-acre Woodland farm, as usually mechanized, returns a satisfactory net income level only if farmed rather intensively. However, on the 820-acre and 1,500-acre farms, high net incomes are possible with fairly low intensive cropping systems.

(6) In most cases where the operator is short on working capital, production loans at presently available interest rates are an excellent investment.

(7) In general, the <u>absolute</u> "risk" or income variability (in dollars) increases with size of operation and level of net income. However, the relative income variability (income variability as a percentage of income level) often decreases as incomes rise.

(8) Moderate farm wage increases might reduce the importance of tomatoes as a major cash crop in the area, particularly in view of the risks associated with tomato production. However, sugar beets would remain in Yolo County cropping systems under any foreseeable wage increases.

investment to a level more consistent with the size of operation. Although some excess machinery is probably desirable as a safety measure in view of consideration in regions of unfavorable weather, some farmers in the Woodland area have machinery capacity far in excess of that required merely for "insurance."

(3) A 225-acre Woodland farm, if well organized and managed, is in a reasonable position economically. Even with adequate operating capital and normal or favorable crops, the operation generally is not sufficiently large to return a market rate on investment in land and equipment plus a satisfactory operator income. However, if the machinery (usually owned by the family farmer) is used more efficiently by renting additional land, satisfactory income would be possible.

(5) A [illegible]-acre irrigated farm, generally [illegible], achieves a satisfactory net income level only if farmed under intensively [illegible]; the 400-acre and 1,000-acre farms, without [illegible], are [illegible] with [illegible] extensive cropping systems.

(6) In most areas where the [illegible] of [illegible] is [illegible], production loans are currently available [illegible] for an excellent investment.

(7) In general, the absolute "risk" or income variability (in dollars) increases with size of operation and level of net income. However, the relative income variability (income variability as a percentage of income level) tends to decrease as income rises.

(8) Potential fluctuations in [illegible] indicate the importance of tomatoes as a major cash crop in the area, particularly in view of the risks associated with tomato production. However, [illegible] profits in Yolo County [illegible] higher than any [illegible] increases.

These points illustrate the nature of the results of this study. It is emphasized that the specific results pertain only to the Woodland area and are based on definite assumptions as to yields, costs, prices and other important economic variables.[1/] While the study covers many typical situations, it obviously cannot examine all possible situations. However, budgeting costs and returns as a means of comparing alternatives can be used to advantage by farmers and others in arriving at decisions for particular situations in both the Woodland area and in other areas.

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1/ See Appendix A.

GUIDES TO PROFITABLE CROPPING SYSTEMS FOR YOLO COUNTY FARMS

by

G. W. Dean and H. O. Carter[1/]

INTRODUCTION

This report pertains to the irrigated cash crop farming area surrounding Woodland in Yolo County, California. The Woodland area is relatively homogeneous with respect to climate, water and soil conditions, and crops commonly grown. Soils are primarily of the highly productive Yolo series. Most farm land is developed for irrigation, with a good water supply accessible primarily from pump irrigation. Crops commonly grown are alfalfa, barley, sugar beets, processing tomatoes and milo; lesser acreages are planted to pink beans, safflower, wheat, field corn, alfalfa seed and sudan grass seed. Few farms in the area raise livestock. Most farms are highly commercial operations, although differing markedly in size and often in particular cropping systems followed. Though the farms are highly mechanized, hired labor inputs are sizeable, particularly for farms raising tomatoes and sugar beets.[2/]

OBJECTIVES AND METHOD OF ANALYSIS

Research in agricultural production concentrates primarily on specific problems constituting only one phase of the farm business,

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1/ Assistant Professors of Agricultural Economics, Assistant Agricultural Economists in the Experiment Station and on the Giannini Foundation, University of California, Davis, California.

2/ An earlier report, summarizing cost relationships, provides more detailed background and information about agriculture in the Woodland area. See: Dean, G. W. and H. O. Carter, Cost-Size Relationships for Cash Crop Farms in Yolo County, California, Giannini Mimeographed Report No. 238, Dec. 1960.

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by

[illegible]

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[illegible]

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1/ [illegible]

2/ [illegible]

such as fertilizer-yield response, varietal selection, insect and disease control, and mechanization. Answers to these specific "sub-problems" are vital to farming success. However, farm managers are also faced with the overall problem of coordinating or "tieing-together" these diverse parts of the farm business into a workable, profitable unit. This problem has taken on greater importance in recent years as farmers have attempted to reorganize their operations for greater efficiency in the face of rising costs and steady or declining product prices. This report is intended primarily as a guide to selection of profitable combinations of crops and practices for typical farming situations in the Woodland area. As such, the report should be helpful both to farmers and to agricultural specialists advising farmers. While the specific results apply only to the Woodland area, the principles discussed have application to other agricultural areas.

Specific objectives of this study are:

1. To estimate cropping systems for the Woodland area which maximize farm profits, given definite assumptions as to resource and institutional situations, expected yields, prices and efficient crop production techniques.
2. To estimate the levels of income possible from these efficient resource combinations and cropping systems.
3. To measure the "risk" or "income variability" associated with each of the cropping systems.
4. To suggest profitable methods of expanding the volume of farm business and net income, considering the possibilities of renting additional land and/or intensifying crop production on smaller acreages.

such as fertilizer-[illegible] response, [illegible], insect and disease control, and mechanization, research to date has [illegible] emphasis [illegible] specific production problems. However, farm managers are also faced with the overall problem of coordinating the various components of the production process into a complete, operational unit. This problem has taken on greater importance in recent years as farmers have attempted to rationalize their operations for greater efficiency in the face of rising costs and stable or declining product prices. This research is intended primarily as a means of identifying profitable combinations of crops and practices for typical farming situations in the [illegible]. As such, the report should be helpful both to farmers and to agricultural specialists and [illegible]. While the specific results apply only to the conditions [illegible], the procedure used should be applicable to other agricultural areas.

Specific objectives of this study are:

1. To estimate cropping systems for the [illegible] which maximize farm profits, given specific assumptions as to resource and institutional situations, commodity prices, yields and efficient crop production techniques.
2. To estimate the levels of income possible from these efficient resource combinations and cropping systems.
3. To quantify the "yield" or "income variability" associated with each of the cropping systems.
4. To suggest additional methods of improving the [illegible] income, [illegible] of [illegible] additional farm [illegible] production of [illegible] crops.

Linear programming--an advanced method of comparing budgeted alternatives--is the basic research tool employed.[1/] The method mathematically selects the particular combination of crops which maximizes profits, given definite assumptions of yields, prices, resources available and other restrictions such as acreage allotments. It is emphasized that the "optimum" or "most profitable" cropping systems referred to in this study always pertain to a specific set of farming conditions. The conditions assumed are those typically found in the study area. However, because individual farm situations seldom correspond exactly to the assumed conditions, the plans and incomes presented should be considered only as guides.

In addition to estimating "optimum" cropping plans and corresponding net incomes, a supplementary analysis also provides a measure of the "risk" or "variability" of net income from each cropping system.[2/] Even in an irrigated agriculture, price and yield variability are pronounced for particular crops and cropping systems. Measures of both income variability and income level should be considered in choosing among alternative cropping systems. For example, suppose two cropping systems yield approximately the same level of net income, but differ widely in income variability. Obviously, most farmers in this situation would choose the lower risk cropping system. However, suppose the

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1/ See Heady, E. O. and Wilfred Candler, Linear Programming Methods, Chapter 7, The Iowa State College Press, Ames, Iowa, 1958.

2/ Appendix B provides basic data used in obtaining the variability estimates presented. For details regarding the procedure underlying these variability estimates see: Carter, H. O. and Dean, G. W., "Income, Price and Yield Variability for Principal California Crops and Cropping Systems," Hilgardia, Vol. 30, No. 6, October, 1960, and G. W. Dean and H. O. Carter, "Measurement of Enterprise Variability by the Variate Difference Method," Agricultural Economics Research, Vol. XII, No. 2, April, 1960.

higher average income can be achieved only with greater risk or income variability--often the realistic case. In this situation, some farmers might prefer to "play it safe" and be satisfied with a lower but less variable income. Other farmers might prefer to take the greater risk in order to achieve higher average income. Such a choice can be made only by the farmer himself, depending on his capital position, family responsibilities, gambling instincts and other factors. Therefore, estimates are presented of both income level and income variability to aid him in his choice.

A separate but related question is also examined: How much can prices, yields or labor costs vary before a <u>different</u> cropping system becomes more profitable? This information provides the farmer with further knowledge of the stability of the most profitable cropping system.

RESOURCES AND OTHER RESTRICTIONS

Land and Machinery

Alternative cropping systems are analyzed for farms in four "size" categories. Two related measures of "size" are used--one based on land, the other on machinery. The four "land size" categories are 160-320 acres, 320-640 acres, 640-1200 acres and over 1200 acres.[1/] The four "machinery size" categories (table 1) are based on typical machinery combinations for each of the four "land size" categories.

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1/ Size categories determined on the basis of a 1959 survey of farmers in the Yolo County area. See: Dean and Carter, <u>Cost-Size Relationships</u>. . . .

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

TABLE 1

Typical Machinery Combinations for Farms of Various Size, Yolo County 1958 a/

Type of machine		I (160-320 ac.)	II (320-640 ac.)	III (640-1200 ac.)	IV (1200 ac. and more)
		Machinery combination for farm sizes			
		No. of each type of machine			
Automotive equipment					
Pickups		2	2	3	4
Trucks-flatbeds		1	1	2	3
Trailers-highway		1	1	2	3
Trailers-lowbed		1	1	1	1
Implement carryalls		1	1	1	2
Power equipment	40 CDBHP b/	1	0	1	1
Crawler tractors	50 "	0	1	0	0
	60 "	1	1	2	2
	100 "	0	0	0	1
Wheel tractors	20 "	2	1	2	4
	30 "	0	1	1	2
Land preparation equipment					
Chisels		1	1	2	3
Harrows-spike		1-12'	1-18'	2-20'	2-30'
Harrows-spring		1-12'	1-18'	2-20'	2-30'
Harrow cart		0	1	1	3
Roller		1-12'	1-18'	1-20'	1-25'
Tool bar		1	1	1	3
By hoe		0	0	1	1
Ditcher		1	1	1	1
Disk: up to 8'		1	0	0	0
8 - 14'		1	2	1	3
14'		0	0	1	3
Plow: 1-2 bottom		0	0	0	1
3-5 "		1	1	1	3
Planting & cultivating equip.					
Tomato planter		0	0	2	2
Seeder		1	1	1	2
Drill		1	1	1	1
Cultivator		2	2	3	3
Beet thinner		0	0	1	1
Sprayer		1-200gal.	1-400gal.	1-500gal.	1-600gal.
Duster		0	0	0	1
Ridger		0	0	1	1
Lister		0	1	1	1
Harvesting equipment					
Beet digger - 1 row		0	1	0	1
Beet digger - 2 row		0	0	1	1
Combine (self-propel)		1-12'	1-12'	1-16'	2-16'
Mower		1-6'	1-8'	2-6'	2-8'
Baler		0	0	0	1
Rake		2	2	2	3
Bale loader		0	0	0	1
Beet topper		0	0	1	1
Land leveling equipment					
Land plane		0	1	1	2
Drag or float		0	1	1	1

a/ Source: 1959 sample of Yolo County cash crop farms: See Dean and Carter, Cost-Size Relationships. . . .

b/ Calculated Draw Bar Horse Power

Profitable cropping systems are determined for "typical" or "representative" farms in each "land size" category: 225 acres (Size I); 480 acres (Size II); 820 acres (Size III) and 1,500 acres (Size IV). For purposes of analysis, total acreage in each case is divided into two soil categories: Yolo A soils (consisting of Yolo fine sandy loams, silt loams and loams) and Yolo B soils (consisting of Yolo clay loams and clays). Both soil categories are deep, friable, productive soils, free from alkali and adapted to a wide range of crops. While crop yields are relatively high on both soils, farmers prefer the Yolo A soils, primarily because timing of tillage operations is less crucial. For most crops, average yields are slightly lower on the heavier soils. Soils information on individual farms indicates approximately a 2:1 ratio of Yolo A: Yolo B soils on farms in the I-III size categories. However, the larger farms (size IV) tend toward a larger proportion of heavier soils, approximating a 1:3 proportion of Yolo A: Yolo B soils.[1/]

Profitable cropping systems are also determined for each of the four "machinery size" categories. That is, the acreage of land farmed is allowed to expand by renting until power machinery is used to capacity in key time periods of the year.

Crop Rotations and Allotments

No rigid complete crop rotations are specified in this study; however, certain limitations are imposed concerning maximum or minimum allowable acreages of particular crops. Tomatoes are limited to

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1/ Soil information based on farm survey: Dean and Carter, Cost-Size Relationships. . . .

Tetrazole compound systems are [illegible] for [illegible] or [illegible] found in each [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. The [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].[illegible]

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[illegible]

25 percent or less of the land on Yolo A soils and 20 percent or less of the land on Yolo B soils, because of the danger of nematode damage from more intensive use. For the same reason, sugar beet acreage is limited to 25 percent or less of both Yolo A and Yolo B acreage. Alfalfa, considered the core of all rotations in the area, is required to be planted on a minimum of 25 percent of both soil classes. Realistically, for a short time period, these restrictions need not be rigidly met. For example, with favorable prices tomatoes might be planted more often than specified. However, in long-run cropping systems, the above rotational restrictions appear reasonable.1/

Institutional factors also influence cropping systems. On rented land, for example, the landlord often specifies certain restrictions on the cropping system. Thus, in addition to the rotation (physical) restrictions above, it is assumed that the landlord requires that at least 20 percent of the cropland be planted to the high income crops of tomatoes and/or sugar beets. Acreage allotments "typical" of farms in each size category also impose restrictions on particular crops. Sugar beet acreage allotments assumed are 50 acres (Size I), 86 acres (Size II), 115 acres (Size III) and 150 acres (Size IV).2/ Thus, sugar beet allotments increase disproportionately with acreage operated. Also, wheat allotments are set at 15 acres--the maximum acreage for a "new" grower. While a few farmers in the Woodland area have larger wheat allotments, the majority have no acreage history and would be subject to the 15-acre maximum.

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1/ A few growers specialize in tomato production by renting different parcels of land each year. However, the more usual case is where the grower operates particular parcels of land for several years.

2/ Based on survey information: Dean and Carter, Cost-Size Relationships. . . .

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Operating Capital

Operating capital available for farming operations is often restricted--sometimes by lending agencies and sometimes by the operator's unwillingness to borrow money or risk his own funds. Even for farmers with similar resources of other types (land, machinery, labor, etc.), the operating capital supply often varies widely. Consequently, profitable cropping systems also vary widely for these farms. Cropping plans therefore are presented for a range of operating capital levels for each farm size and situation. Operating capital is required only for those expenses which vary with production in a particular year; i.e., labor, fuel, oil, seed, fertilizer and similar expenses. Fixed costs such as depreciation, interest on investment in land and machinery, taxes and insurance are not included directly in operating capital requirements, but are deducted in arriving at net income figures. No interest is charged on operating capital in this study. Optimum farm plans for any situation would not change significantly by including this refinement. However, if desired, the net income figures reported later can be adjusted downward accordingly.

Labor and Water

Labor and water are typically listed as resources limiting agricultural production. However, it is doubtful that labor and water constitute real short-run restrictions on farming in the Woodland area. Hired labor is available at going wage rates ($1.50 for machinery operation and $1.15 per hour for hand labor) in essentially unlimited supply to any individual farmer, provided he has contracted sufficiently far in advance to insure transportation and adequate housing.

[illegible]

[illegible]

[illegible]

[illegible]

The restriction on labor is probably handled adequately by specifying the amount of operating capital available: the greater the capital supply, the greater the amount of labor which can be hired.[1/] However, future developments in the Mexican National program and labor unionization may increase labor costs or limit the supply of labor. The effects of increased wage rates are examined later in the report.

Water supply also is an important restriction in certain areas of California, such as the Westside of the San Joaquin Valley. However, in the Woodland area, farms developed for irrigation usually have a water supply adequate in all seasons for any feasible cropping system. Therefore, water supply is not explicitly included as a restriction on crop production.

Managerial Ability

Managerial capacity of the individual operator is another important limiting factor, but an elusive one to measure. Therefore, above average management is assumed throughout this analysis. That is, the manager is assumed to have the necessary experience and supervisory ability to operate in an efficient manner (as reflected in yields and costs) any of the farm plans developed in the subsequent analysis.

CROPPING ALTERNATIVES

Many crops are adapted to soil and climatic conditions in the Woodland area. Given the resources available for production, the problem is to find the combination and acreages of these crops which

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1/ Of course, some farmers object to use of seasonal hired labor and therefore avoid growing the labor-intensive crops entirely.

promise greatest returns. The solution to this problem requires information regarding yields per acre, prices, costs, resource requirements and leasing arrangements (if rented) for each crop for each situation studied.

Table 2 summarizes yield and fertilization assumptions for the various crops considered. Yields are those expected under efficient management, present production methods and "normal" growing conditions. Yield and fertilizer levels were based primarily on estimates provided by University of California research and extension personnel familiar with the Woodland area.

Table 3 summarizes prices assumed for the analysis. The prices are conservative "judgment" estimates for the near future, in most cases slightly lower than prevailing prices in 1958-59. Particular emphasis is placed on comparative prices among crops since <u>relative</u> prices are more important for analytical purposes than the <u>absolute</u> price level.

Cost data, too extensive for inclusion here, are summarized in Appendix A. While yields for particular soils and prices are assumed constant for farms of all sizes,[1/] variable costs per acre change as larger machinery is used. Labor, fuel, and other variable operating expenses per acre decrease with increased farm size. All yield, price, cost and returns data used are based on expected "normal" conditions. Unfortunately, even in an irrigated agriculture, "normality" is seldom experienced. Therefore, as discussed earlier, the analysis provides a measure of the net income variability expected from each cropping system.

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1/ No significant relationship between yield per acre and size of farm was evident for the surveyed farms.

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[illegible]

[illegible]

[illegible]

[illegible]

TABLE 2

Per Acre Yield and Fertilization Assumption
for Yolo County Crops a/

Crop		Soils					
		Yolo - A			Yolo - B		
Tomatoes b/	Yield and fertilizer level	20 0	24 80#N and 25#P_2O_5		19 0	23 80#N and 25# P_2O_5	
Sugar beets c/	yield-tons fertilizer % sugar	17 0 16.0	22 80#N 15.7	25 160#N 15.0	17 0 15.0	22 80#N 14.7	25 160#N 14.0
Alfalfa d/	yield-tons fertilizer	7.5 0			6.5 0		
Pink beans	yield-lbs. fertilizer	2200 0			1800 0		
Alfalfa seed	yield-lbs. fertilizer	500 0			400 0		
Safflower	yield-lbs. fertilizer	1800 50#N			2000 50#N		
Barley	yield-lbs. fertilizer	3400 30#N			2800 30#N		
Wheat	yield-lbs. fertilizer	3000 40#N			2400 30#N		
Milo	yield-lbs. fertilizer	5000 125#N			4000 125#N		
Corn	yield-lbs. fertilizer	6500 150#N			5500 125#N		
Sudan grass seed	yield-lbs. fertilizer	2600 50#N			2200 50#N		

a/ All estimates except tomatoes and sugar beets obtained from Milton D. Miller, Department of Agronomy, University of California, Davis, and adjusted on the basis of "normal" yields estimated from a sample of 37 Yolo County farmers in 1959.

b/ Tomato estimates obtained from John Lingle, Department of Vegetable Crops, University of California, Davis.

c/ Sugar beet estimates obtained from Jack Hills, Department of Agronomy, University of California, Davis, and Dan Deter, Spreckles Sugar Company, Woodland, California.

d/ Four year stand assumed.

TABLE 3

Price Assumptions for Yolo County Crops

Crop	Unit	Percent sugar content	Price per unit
Tomatoes	ton		$22.00
Sugar beets	ton	16%	13.80
		15.7%	13.55
		15%	13.00
		14.7%	12.75
		14%	12.20
Alfalfa	ton		22.00
Pink beans	cwt.		6.50
Alfalfa seed (Buffalo & Ranger)	cwt.		27.00
Safflower	ton		75.00
Barley	cwt.		2.00
Wheat	cwt.		3.00
Milo	cwt.		2.10
Corn	cwt.		2.50
Sudan grass seed	cwt.		5.00

Source: Estimated by authors.

GUIDES TO PROFITABLE CROPPING SYSTEMS

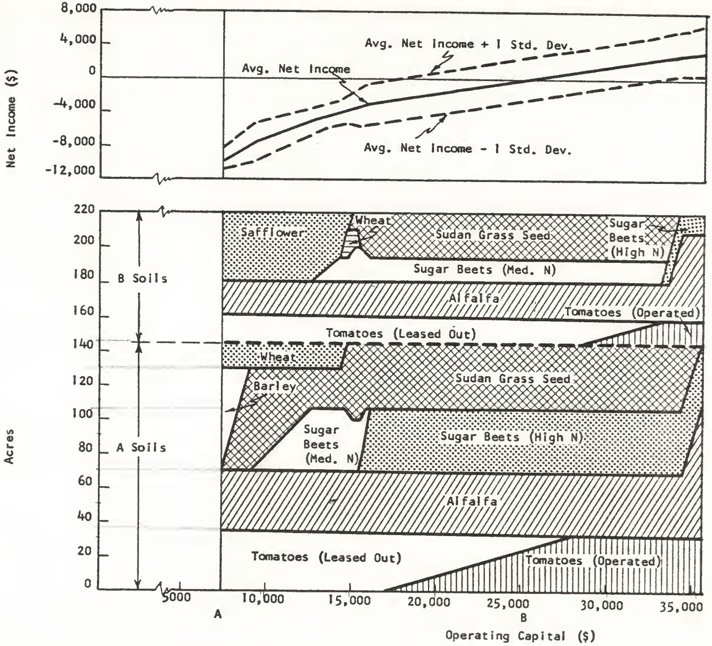
"Optimum" or "most-profitable" cropping systems (as derived by linear programming) are now presented for various "typical" resource situations on farms in the four general "size" categories. First, plans are presented for farms of a fixed acreage representative of farm size, tenure, resources and allotments within that group. Machinery is not a limiting factor in these plans. Second, plans are presented for each size group showing the optimum method of expanding net income where additional land can be rented until the machinery (typical of farms in the size group) is utilized to capacity in the crucial time periods during the year.

Farm Size I

Owned farm

The farm constructed to represent a "typical" owned farm in size group I is 225 acres in size, consisting of approximately 145 acres of Yolo A soils and 80 acres of Yolo B soils. Figure 1 represents a diagrammatic presentation of the most profitable cropping plans for different levels of operating capital. The diagram is read as follows: Select the level of operating capital available to the farmer on the horizontal axis at the bottom of the diagram. Read vertically upward (off the scale on the extreme left) from this point to determine the acreage of each of the crops--first those grown on the better A soils (totaling 145 acres), then those grown on less productive B soils (totaling 80 acres). The average net farm income corresponding to this plan and a measure of net income variability are read off a

Owned 225 Acre Farm.



different scale at the top of Figure 1 [1/]. The dark center line represents average net income and the dashed lines on either side represent plus and minus one standard deviation from average net income.[1/]

As an example, assume that a farmer has approximately \$7,500 in operating capital (point "A" in Figure 1). Reading vertically from "A," the optimum cropping plan for the owner-operator is: 36 acres of tomatoes leased out, 36 acres of alfalfa, 58 acres of barley and 15 acres of wheat (all on the better A soils totaling 145 acres); 16 acres of tomatoes leased out, 20 acres of alfalfa and 44 acres of safflower (all on the Yolo B soils totaling 80 acres). The average net income from this plan is -\$9,650, with a variability range from -\$10,980 to -\$8,315.[2/] The optimum cropping systems for increasing levels of operating capital up to \$35,000 are read from the graph similarly. As one more example, assume that a farmer has \$25,000 in operating capital (point "B" in Figure 1). Reading vertically from "B," the optimum cropping plan is: 24 acres of tomatoes operated by the owner, 12 acres of tomatoes leased out, 36 acres of alfalfa, 36 acres of sugar beets and 38 acres of sudan grass seed (all on A soils); 16 acres of tomatoes leased out, 20 acres of alfalfa, 14 acres of sugar beets and 29 acres of sudan grass seed (all on B soils). This is approximately a breakeven point, where net income is essentially zero, plus or minus about \$2,400. Other diagrams throughout this report are to be interpreted in the way outlined here.

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1/ Assuming that (with trend removed) net incomes are distributed normally about the mean income, net income should fall within the range of $\pm$ one standard deviation about two-thirds of the time.

2/ Though the net income from this plan represents a loss, it is the plan which minimizes the possible loss. Any other plan, under the conditions assumed, would involve greater losses.

An important farm management principle can be demonstrated by discussing changes in the optimum cropping systems as more operating capital becomes available. The principle can be stated as follows: Select those crops which provide the greatest return per unit of the most limiting resource(s). For example, if operating capital is extremely limited, select those enterprises giving highest returns per dollar of operating capital; on the other hand, if labor is very limited but capital is ample, select those enterprises giving highest returns to labor. The limiting resource can be "stretched" in this way. While this principle becomes more difficult to apply as several resources become limiting simultaneously, the idea can be used to advantage in many situations.

This principle is demonstrated in Figure 1. At the lowest capital level considered (point A with about $7,500), funds are extremely limited. Therefore, crops are selected which provide high returns per dollar of limited funds. Table 4 shows the relative rates of "net" returns per dollar of operating costs for the various crops.1/ With limited funds, first priority goes to tomatoes (leased out)--this crop provides the owner-operator with a per acre "net" income of $79 on A soil and $76 on B soil with no operating costs. Therefore, the maximum acreage of tomatoes allowed by nematodes and contracts (25% of A soil and 20% of B soil) is leased out to a tomato grower. The acreage of alfalfa required to meet rotation requirements is also planted. The remainder of the A and B land is planted to the other crops providing the greatest return per dollar invested. Aside from leased tomatoes, the crops with highest "net" income per dollar of operating capital on A soil are: wheat ($2.73 return per dollar of variable cost) and barley

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1/ "Net" return as used here refers to gross income minus direct operating costs only. Inclusion of such costs as taxes and depreciation would reduce the "net" figure considerably. However, because these costs are fixed or "given" for the year, they do not affect the most profitable use of operating capital.

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TABLE 4

Relative "Net" Returns per Acre and per Dollar of Operating Costs for the Owner-Operator in Size Group I. a/

Crop	A Soil			B Soil		
	"Net" return per acre	Operating costs per acre	"Net" return per dollar of operating costs	"Net" return per acre	Operating costs per acre	"Net" return per dollar of operating costs
	dollars					
Tomatoes (hi N, owned)	197	331	0.59	183	323	0.57
Tomatoes (hi N, leased out)	79	0	---	76	0	---
Sugar beets (med. N)	149	149	1.00	131	149	0.88
Sugar beets (hi N)	157	168	0.94	137	168	0.82
Alfalfa	82	83	0.98	65	78	0.84
Pink beans	69	74	0.93	45	72	0.63
Alfalfa seed	67	90	0.74	40	90	0.44
Safflower	42	26	1.62	49	26	1.87
Barley	46	22	2.15	34	22	1.59
Wheat	66	24	2.73	49	23	2.17
Milo	57	48	1.19	36	48	0.75
Corn	55	107	0.51	44	94	0.47
Sudan grass seed	79	51	1.54	61	49	1.25

a/ "Net" return = gross income - direct operating costs.

($2.15 return per dollar of variable cost). The 15-acre wheat allotment is therefore planted and the remaining A land goes to barley. A farmer with a larger wheat allotment and limited capital would benefit by shifting from barley to wheat. Aside from tomatoes (leased out) and wheat (already planted to the full allotment on A land), safflower provides highest returns per dollar ($1.87) on B soil and therefore fills out the cropping system on B soil.

As additional operating capital is employed in the business, land rather than capital becomes the most limiting resource. Therefore, profits are increased by successively shifting to crops with a high return per acre rather than per dollar of operating cost. Figure 1 shows how the cropping system intensifies as crops with higher returns per acre enter the cropping system, replacing such crops as wheat and barley which have high returns per dollar of cost, but low returns per acre (Table 4). Thus, sudan grass seed ($79 return per acre) replaces barley ($46 return per acre) on A soil; sugar beets fertilized at the medium nitrogen level ($149 return per acre) enter the plan and expand until reaching the 50-acre allotment. Beyond about $15,000 in operating capital the cropping system intensifies greatly as sudan grass seed ($61 return per acre) replaces safflower ($49 return per acre) on B soil, tomatoes are shifted gradually to an owner operated basis rather than leased out and sugar beets are fertilized at the high nitrogen rate. At the extreme upper capital limit ($35,450) the entire farm is planted to crops giving the highest net income within the institutional and rotational limits (i.e., maximum allowable acreage of tomatoes and sugar beets are planted and the remainder of the land is planted to alfalfa).

The income variability boundaries of Figure 1 provide a measure of the "risk" attached to each cropping system. The net income variability increases from about ±$1,500 to ±$3,000 as operating capital increases from the lowest to highest levels. The "bulges" in variability

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parallel the entrance of high variability crops such as sudan grass seed and tomatoes into the cropping plan. Some farmers may prefer the less intensive, lower income plans which involve less "risk."

The "fixed costs" for the Size I owner-operator are \$23,772 (see Appendix Table A-3).[1/] This level of fixed costs is so high relative to the size of the farm that the highest "net income" possible (even with \$35,000 in operating capital) is only about \$3,000. These results supplement an earlier study indicating the relative inefficiency of small farms in the Yolo County area.[2/] Of course, if the operator owns the farm debt-free, the interest on his land investment (\$10,800) is not a cash cost and he may be able to stay in business. However, he would be receiving a rate of return on his investment below market rates. In any case, the smaller owner-operated farm in the Yolo County area is in a vulnerable economic position, particularly if the owner does not have high equity in his land.

Several possibilities exist for improving income levels on smaller farms. One possibility is to reduce machinery investment and fixed costs through use of more custom operations or through joint ownership of equipment. In some instances, more drastic possibilities may be considered. For example, some smaller farmers in Yolo County have either sold their farms outright or rented them out to larger operators. A simple example illustrates that these alternatives may hold promise either for the retiring farmer or for a younger man who wishes to

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1/ "Fixed costs" for the owner-operator include depreciation, interest on investment, taxes and insurance on machinery and interest on investment and taxes on land.

2/ Dean and Carter, Cost-Size Relationships. . . .

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seek nonfarm employment. Assume an owner-operator of 225 acres who leases out his entire farm and sells his machinery and equipment. Under the price, yield and rental assumptions of this study and assuming his tenant farms the land intensively to tomatoes, sugar beets and alfalfa (corresponding to the cropping system for \$35,000 in Figure 1), the owner's share rent is \$12,052. A 6% return on capital formerly invested in machinery adds another \$2,032, making his gross income \$14,084. Interest on land (\$10,800) and land taxes (\$1,800) constitute farm expenses, leaving a net farm income of \$1,484. The owner would have to operate quite intensively himself (using \$28,000 or more in operating capital, Figure 1) to equal this net income. Furthermore, in the case of renting the land out, the owner could take a full-time nonfarm job, which would easily increase his total net income above that possible from actually operating the 225 acres.

Rented farm

Share-renting is a common practice in Yolo County. Therefore, optimum cropping plans are presented for a size I farm (145 acres of Yolo A soils and 80 acres of Yolo B soils, totaling 225 acres) operated under a share-renting arrangement.[1/] Figure 2 illustrates the most profitable plans for share renters with different levels of operating capital.

At a limited operating capital level of \$10,000, necessary rotation requirements are met first, with the remaining crops selected on the basis of high returns per dollar of cost. In keeping with the rotation restriction, 56 acres is planted in alfalfa (36 acres on Yolo A soil and 20 on Yolo B). Fifteen acres are planted to wheat (maximum allowed by allotment), because wheat provides highest "net" return per dollar

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1/ See Table A-5 for the share-rental contracts assumed in the analysis.

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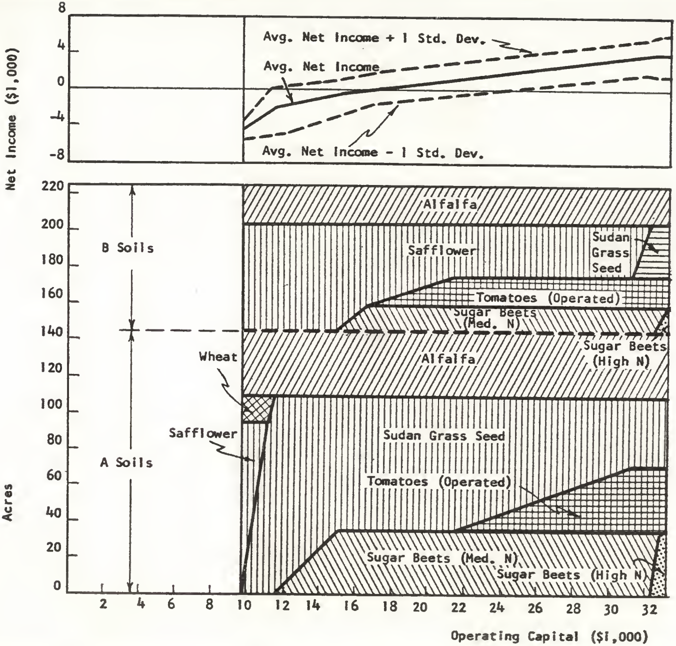
Rented 225 Acre Farm.



of variable cost for the renter ($1.25 and $0.87 return return per dollar of variable cost on A and B soils, respectively). The remaining 154 acres (95 acres on Yolo A soil and 59 on Yolo B soil) are planted to safflower--another crop with a high return on operating capital.1/

A significant shift occurs in the most profitable cropping system when available operating capital increases from $10,000 to $12,000: Land in safflower and wheat (110 acres) on the Yolo A soil is replaced by sudan grass seed. The logic of this shift is that returns per acre of sudan grass seed are $46 compared to only $25 and $30, respectively, for safflower and wheat, while returns per dollar of operating capital for sudan grass seed are only slightly less than for wheat or safflower ($0.92 for sudan grass seed compared to $0.96 and $1.25 for safflower and wheat, respectively). A continuous change from crops giving high returns per dollar of cost to those yielding high acre returns is observed in Figure 2 as the operating capital level expands beyond $12,000. At the highest level of operating capital ($33,320) the cropping system reaches maximum intensity: Tomatoes (operated) and sugar beets are expanded to the maximum allowable acreage under the rotation and allotment restrictions for Yolo County farms. Aside from the "required" 56 acres of alfalfa (36 acres on A soil and 20 acres on B soil) the remaining acreage is planted to sudan grass seed--the crop with highest net return per acre to the renter except for tomatoes and sugar beets. Unfortunately, the net income variability of sudan grass seed (resulting

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1/ No safflower restriction is included in this study because safflower is not subject to rigid government acreage allotments. However, safflower is a contracted crop, and therefore this study assumes that the farmer is able to secure the needed contractual arrangement. This assumption will not be valid in all cases, requiring substitution of another crop and consequent downward adjustment in net income.

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primarily from price and yield variability) is relatively high. Thus, Figure 2 shows that the net income boundaries widen substantially when sudan grass seed first enters the program. The boundaries then narrow as sugar beets--a relatively stable crop--partially replace the sudan grass seed, then widen again as tomatoes enter the cropping system at higher capital levels. The fact that the lower income variability boundary equals the break-even net income at a rather high level of operating capital emphasizes the precarious position of the under-capitalized small farmer.

The trend toward intensification of the cropping system when more capital is employed corresponds closely to the experience of many operators who begin farming with limited funds, gradually become better established financially and finally progress toward more intensive, higher income alternatives. The striking difference between plans for farmers with low versus high operating capital emphasizes a point too often ignored: What is profitable for a single successful farmer is not necessarily profitable for everyone in the neighborhood. Too often, the successful farmer is looked at as a model for younger inexperienced farmers to follow. Figures 1 and 2 clearly illustrate, as will other examples later, that the optimum organization for the under-capitalized farmer is quite different from that for the operator with sufficient capital.

Size considerations are extremely important in agriculture. The net income data of Figure 2 emphasize the "scale" problem facing California farmers. Fixed costs for the 225-acre share-renter (Size 1) are $11,172 (see Appendix Table A-3). Net incomes for farms organized on this basis do not reach a break-even point until operating capital of about $17,000 is available; the highest income possible is only

about $4,000. Again, however, interest on the capital investment (only machinery for the renter) is included in costs. Compared with owner-operators on farms of the same acreage, less operating capital ($17,000 for the renter compared to $25,000 for the owner-operator) is required for a tenant to reach the break-even net income point; one reason is that fixed costs are excessively high for owner-operators on small units. These results indicate that small operators may fare better by investing scarce capital in crop production and machinery while renting rather than becoming "land poor."

A few share renters in the Yolo County area are employing a unique rental pattern in order to obtain satisfactory incomes on limited acreages. These renters are crop specialists, raising only tomatoes or perhaps tomatoes and sugar beets. They avoid disease problems by renting different parcels of land from year to year. While these farms are small in terms of acreage, they require high levels of operating capital and are subject to considerable risk, both from yield and price variability and from uncertain tenure arrangements from year to year. For example, a renter specializing in 225 acres of tomatoes, and using the price, yield and cost assumptions of this study, would have an average net income of about $13,125, but with a variation of ±$5,325.

Expansion in size of rented farm

Farmers in Yolo County and other areas of California often expand the scale of their operations as one means of combating the price-cost squeeze. Part of the economies realized through expansion stem from spreading fixed machinery costs over more acres or units of output. Accordingly, crop plans are now presented showing the most profitable method of expanding the farm business through renting additional land; however, machinery is limited to that typically found

on the 160-320 acre farm (Size I machinery, Table I). Thus, the ultimate limiting factor restricting size in this situation is machinery capacity (specifically, wheel tractor and tracklayer capacity) in crucial time periods during the year. Custom operators are generally available to perform the major harvesting tasks (baling, combining and sugar beet digging). However, in the Woodland area organized custom operators do not ordinarily perform field operations such as heavy tillage, planting, and cultivating. The factor limiting the extent of these field operations is primarily the capacity of the operator's power equipment (tracklayers and wheel tractors). Capacity is determined by computing hours of power time available per time period (based on size and number of tractors, number of nonwet days and a 10-hour work day), compared with crop requirements by time periods.

Figure 3 shows that the initial crops entering the most profitable program are: Tomatoes (subleased), sugar beets (medium fertilization), alfalfa, and sudan grass seed on Yolo A soil, and alfalfa and safflower on Yolo B soil. The subleased tomatoes require little tenant operating capital but (together with the sugar beets) satisfy the landlord's restriction requiring at least 20 percent of the land in high value crops. As additional land is rented up to a maximum of 1,570 acres, tomatoes (subleased) are expanded proportionately, sugar beets are planted up to the allotment of 50 acres, alfalfa is planted at the minimum level consistent with rotation practices in the area (25 percent of the land in alfalfa) and the remaining acres are planted to sudan grass seed. Further expansion beyond 1,570 acres is limited by the capacity of tracklayers during the heavy tillage months of October through February. Given this machinery limitation, additional income is possible beyond this point only by reduction in total acreage and intensification of the operation. The optimum organization is intensified by shifting from

[illegible] (Table 1). Thus, [illegible]

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Figure [illegible] shows that the initial [illegible]

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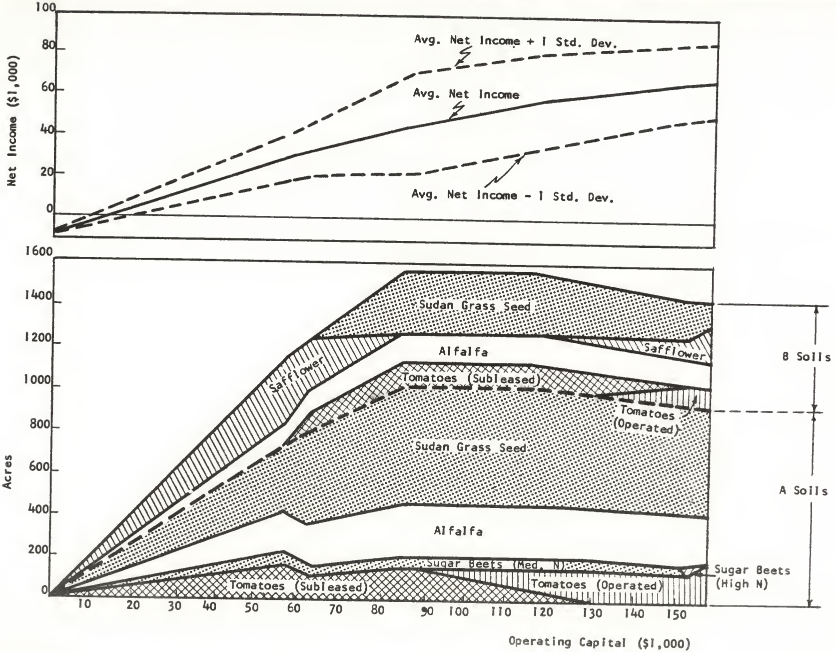
Expanding with Increasing Levels of Operating Capital (Machinery Size 1).



subleased tomatoes to renter-operated tomatoes (at the upper capital level, operated tomatoes even replace sugar beets), while safflower replaces a substantial amount of the sudan grass seed acreage (see Figure 3 at the $158,000 capital level). Under the conditions assumed, no further readjustment in the cropping plan (beyond $158,000 in operating capital, Figure 3) can produce a greater net income.

Net income increases to $66,000 as operating capital reaches a maximum of $158,000. However, net income variability reaches a maximum (±$24,000) at a capital level of only $85,000 then declines slightly with further intensification. The "high" variability at $85,000 in operating capital results from the large acreage of sudan grass seed in the program. It is emphasized, however, that the variability measures used probably underestimate the "true risk" in these cropping systems as machinery is used to increasingly greater capacity. That is, as machinery usage is pushed to near capacity, problems of weather, timeliness of operations, etc. may increase risk beyond the simple measures used in this study. However, it seems clear that the "typical" farm in the Size I group is over-mechanized far beyond the point required as a safety margin for unexpected weather, breakdowns and similar contingencies. For example, the preceding analysis indicates that, with the machinery typically found on Yolo County farms of 225 acres, the operation could expand to about 1,400 acres if machinery were used to "absolute" capacity.[1/] Even allowing a 50 percent safety margin, most farmers in the Size I group could expand to 600-700 acres with the equipment they own. Undoubtedly some of the farmers in Size I group have rented in the past, or intend to rent in the near future, considerably larger acreages--thereby justifying the extensive equipment inventory. In any case, there appears

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1/ "Absolute" capacity for a 10-hour day. Some operators run equipment nights in crucial time periods.

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ample opportunity for many farmers presently in the Size I group to improve income either (1) by expanding acreage to more fully utilize equipment and spread fixed costs, (2) by reducing the machinery inventory and fixed costs in line with the smaller acreage or (3) using custom work as a means of reducing fixed costs.

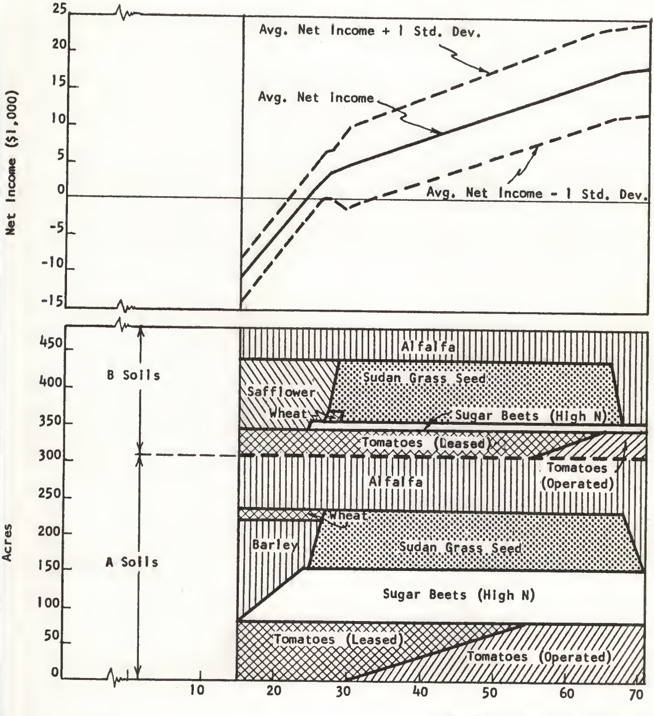
Farm Size II

Owned farm

In size group II, the typical sized farm is 480 acres--320 acres of Yolo A soil and 160 acres of Yolo B soil. Optimum cropping systems, net income and net income variability boundaries corresponding to different levels of operating capital are illustrated in Figure 4.

Once again, crops first entering the plan at minimum capital levels are those with high returns per dollar of cost or those required in the rotation. Thus, tomatoes (leased) are planted to the maximum acreage allowed (78 acres on Yolo A soil and 34 on Yolo B soil), wheat is planted to the allotment limit of 15 acres, the minimum alfalfa acreage is planted and the rotation is filled in with 141 and 92 acres of barley and safflower on A and B soils, respectively. Although the plan just outlined represents the "best possible" for this size farm operating with limited capital ($15,000), the corresponding income represents a net loss of $10,735. Thus even a farm of 480 acres in size (with typical machinery) cannot operate successfully with limited operating capital and a small volume of business. At present prices the operator of a 480-acre Yolo County farm cannot compete in the long run without substantial acreage planted to the higher value crops. Many times the suggested solution for labor problems in agriculture is for the farmer to shift from the

Figure 4. Optimum Cropping Systems, Net Income and Net Income Variability for Owned 480 Acre Farm.



present labor-intensive crops to those more highly mechanized. These data indicate that such a solution is impractical for the smaller sizes of farms in the Yolo County area, at least under present land values and product and factor prices.[1/] Nonetheless, many people who own their land without a mortgage can operate such a rotation with acceptable income levels, provided they are willing to accept negligible returns on their land investment. For example, at the $15,000 capital level of Figure 4, net income is -$10,736. However, interest on the land investment of $23,040 is included as a cost. Ignoring this interest charge as a cost would increase income to $12,304--an income level sufficiently high to maintain a satisfactory level of living for many farm families. The point is, however, that the operator has $384,000 (480 acres at $800 per acre) actually or potentially tied up in land. If this capital were invested, even in a savings bank at 4%, the interest would amount to $15,360 per year with no operator labor or risk. Many farmers are cognizant of these relationships, yet are willing to farm for several rational reasons, such as enjoyment of farming and farm life as an end in itself, hope for better returns ahead and the possibility of land appreciation. Yet the basic economic facts suggested here warrant careful consideration by farm families.

As increasing amounts of operating capital become available for the 480-acre farm, the optimum cropping system shifts more heavily into the high value per acre crops. Figure 4 indicates that a 480-acre farm, if efficiently operated with an intensive cropping system, is sufficiently large to provide a market rate of return on capital investment and still provide a level of net income satisfactory to most families. For example,

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1/ However, important strides are being made in the mechanization of some of the present "labor-intensive" crops. For example, mechanical sugar beet thinning is already widely used while a mechanical tomato harvester will be used experimentally during the 1961 season.

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point is, however, that [illegible]

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at the upper range of intensity where $70,000 of operating capital is employed, the expected net income for this operation is $18,001 with a variation of ±$6,600. Even if the operator must borrow the operating capital, the interest payment is only about $2,450 (7 percent of one-half the total $70,000 required during the year), reducing the net income for this operation to $15,550. These data bring out a significant point for under-capitalized farmers: borrowing operating capital, even at relatively high rates, is often profitable in order to shift from low value to high value per acre crops. These results also suggest a potential source of loans not fully exploited by banks and other credit sources.

Rented farm

Cropping systems yielding the greatest net incomes for different levels of operating capital are now examined for a share-rented 480-acre farm (Figure 5). Compared with the same sized owner-operated unit, less operating capital is required to attain a positive level of net income ($12,000 of operating capital for the renter compared to $24,000 for the owner). The disparity is explained by the relative level of fixed costs for the two tenure situations; the owner's fixed costs are about $41,000 compared to only $14,000 for the share-renter. Thus, in order to obtain a market rate of return on land investment and a comparable net income, the owner-operator is forced to farm a more intensive rotation than the renter.

At low levels of operating capital ($10,000-$15,000), plans for the renter (Figure 5) differ from the owner (Figure 4) only in that they contain more safflower and barley and no leased tomatoes. At increasingly high levels of operating capital, Figure 5 shows that: barley and wheat are replaced by sugar beets (first at a low level of

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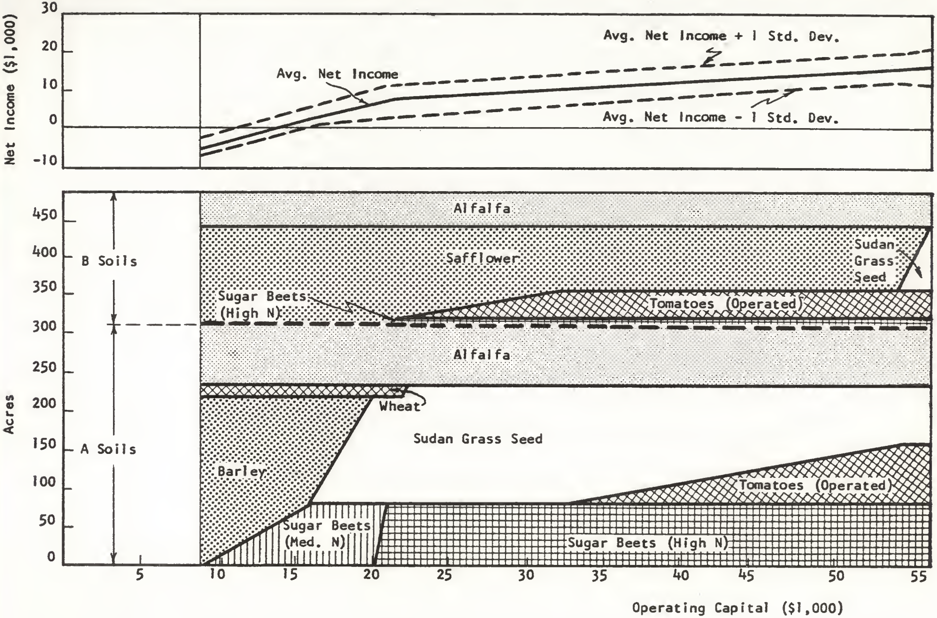
Figure 5. Optimum Cropping Systems, Net Income and Net Income Variability for Rented 480 Acre Farm.



fertilization and then at a high level of fertilization) and sudan grass seed; safflower (on Yolo B soil) first is partially replaced by sugar beets and tomatoes and finally completely replaced by sudan grass seed. The final plan with a high level of operating capital ($56,000) differs from the comparable owner-operated organization in that sudan grass seed replaces alfalfa to the point where alfalfa is at the minimum level required to meet rotational restrictions. The explanation is that, for the renter, sudan grass seed gives a slightly higher net return than alfalfa (e.g., the per acre net return for sudan grass seed on Yolo A soil is $48 compared to $41 for alfalfa).

Net income for the renter varies from a -$5,000 to a +$16,000 depending on the availability and use of operating capital. This compares with a range of -$10,736 to +$18,000 for the owner-operator on the same sized farm. Both situations emphasize the importance of making capital available to farmers in amounts necessary for them to economically utilize their other resources.

Variability of net incomes (Figure 5) tends to increase substantially with the inclusion of sudan grass seed in the rotation. The balance between income level and income variability is often a matter of choice by the individual farmer, depending on his willingness and ability to take risks. For example, many farmers might prefer the plan at $54,000 of capital (Figure 5) rather than the plan for $56,000 of capital; while "on the average" net income is $16,200 for the latter compared with $15,865 for the former, the net income variability is also higher (±$5,140 compared with ±$4,275).

Expansion in size of rented farm

The preceding plans illustrated profitable methods of intensifying crop production on a fixed farm of 480 acres. Profitable cropping plans are now presented where the operator expands the farm business through renting additional acreage, consistent with the capacity of machinery size group II.

fertilization and then at a high level of fertilization; and seeded grass sod; safflower (on Yolo a soil) first [illegible], and [illegible] sugar beets and [illegible] and finally completely replaced by seeded grass sod. The final plan with a high level of operating capital ($25,000) differs from the corresponding lower capital organization in that seeded grass sod replaced alfalfa in the rotation where it is not [illegible] required to meet rotational restrictions. The explanation [illegible] that [illegible] the [illegible] value of seeded grass a slightly higher net return than at [illegible], the per acre net return for seeded grass sod on Yolo soil is $[illegible] compared to $41 for alfalfa).

Net income for the [illegible] [illegible] from $[illegible] to $[illegible],000 depending on the availability and use of operating capital. This compares with a [illegible] to $[illegible] or $[illegible] for the owner-operator on the same size farm. These illustrations emphasize the importance of capital [illegible] to farmers in [illegible] for them to economically utilize their other resources.

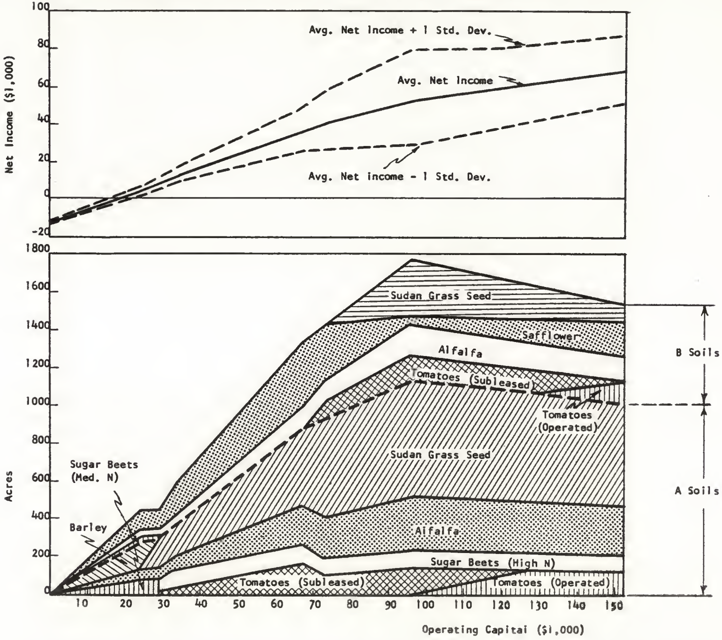
Variability of net income (Figure 5) tends to increase substantially with the inclusion of seeded grass sod in the rotations. The [illegible] between income level and income variability is [illegible] by [illegible] individual farmers, depending on his willingness and ability to bear risk. For example, some farmers might prefer the plan at [illegible] of [illegible] (Figure 5) rather than the plan for $25,000 of capital, since the expected net income is $[illegible] for the latter compared with $[illegible] for the former, and net income variability is much higher ($[illegible] compared with $[illegible]).

Transition [illegible]

[illegible] illustrates possible methods of [illegible] land [illegible] on a [illegible] farm of [illegible] acres. [illegible] plan, the operator [illegible] the [illegible] strategy, consistent with the [illegible].

The optimum expansion pattern shown in Figure 6 for the Size II renter is very similar to that for the Size I renter shown previously in Figure 3. The principal difference is that the tracklayers and wheel tractors are larger (refer to Table 1) in the Size II category and therefore have greater capacity. As a result, the maximum acreage farmed is 1,750 acres compared with 1,570 acres for the Size I group. Net incomes for comparable levels of operating capital also are higher for the Size II renter: While total fixed costs of machinery for the Size II renter are slightly higher, they are spread over a larger output; the saving in labor and other variable costs per acre from the larger equipment more than offsets this slight increase in fixed costs. For the farm as a whole, this cost difference results in a $72,000 net income for the Size II renter versus $66,500 for the Size I renter when both have the maximum ($155,000) operating capital. Despite these impressive earnings with unlimited operating capital, most renters are realistically faced with varying degrees of capital limitations. Thus of more immediate concern is the manner in which the most profitable cropping plan changes as additional operating capital is used. Again the most profitable cropping system at limited capital levels is built around the crops necessary for rotational purposes and those providing high returns on limited capital. An additional restriction which must be met by the tenant is one imposed by the landlord requiring a minimum of 20 percent of the acreage planted to high value crops. Landlords often stipulate such restrictions on the tenant cropping plan in order to insure themselves a higher share rent. Additional capital allows expansion in acres and finally in intensification of the cropping system on fewer acres as machinery becomes a limitational factor.

Figure 6. Optimum Cropping Systems, Net Income and Net Income Variability for Rented Farm Expanding with Increasing Levels of Operating Capital (Machinery Size II).



Up to a net income of about \$38,000 the income variability measures about \$3,500-4,000. With the rapid expansion of sudan grass seed acreage, income variability widens correspondingly. For example, at a net income level of \$55,000 (corresponding to maximum sudan grass seed acreage) the variability is ±\$25,000, or nearly ±50 percent. For the renter, sudan grass seed has the best income prospects of any noncontrol crop aside from tomatoes, but also involves greater risks--sudan grass seed prices are particularly volatile. It should be emphasized again that the actual range of income variability may be wider than shown, particularly at the upper capital levels where machinery approaches engineering capacity based on normal weather. Lack of excess capacity may mean greater losses under unusual weather conditions. To insure adequate machinery to "get the job done" with unfavorable weather, many farmers keep on hand old standby equipment which is depreciated out and has little resale value, but which is serviceable for short periods. The cost of this "insurance" is quite low and would not appreciably lower the net income figures presented.

Farm Size III

Combination owned-rented farm

Previous optimum cropping systems have referred to farms where land is either all rented or all owned. However, many farmers in the Yolo County area operate a combination of owned and rented land, particularly in the size range beyond 300-400 acres. These operators often buy or inherit a smaller farm which they use as a base for extending their operation to a more economic unit by renting additional land. With limited capital the decision to expand by renting rather than buying is probably sound. The analysis here pertains to a typical combination of 820 acres where 300 acres are owned and 520 acres are rented.

The central problem facing the operation in the combination farm is the proper allocation of operating capital and other resources between owned and rented land in order to maximize profits consistent with restrictions imposed by rotations, allotments and by the landlord. Figure 7 shows the optimum pattern of adjustment in crops as increasing levels of operating capital are employed. Initially, tomatoes are leased out on the owned land and subleased out on the rented land, thereby providing high returns with little operating capital. With more capital the operator shifts toward growing his own tomatoes on owned land while continuing to sublease part of the rented land; eventually at the highest capital level the most profitable cropping system includes tomatoes grown by the operator on both owned and rented land. The sugar beet allotment of 115 acres is planted on the better rented Yolo A soil at all capital levels. Other crops follow a sequence of intensification similar to those discussed previously.

Net income for a combination owned-rented operation of 820 acres ranges from $10,000 (with an operating capital level of $36,000) to a high of $38,000. The net income trend is nearly constant with increasing levels of capital--net income increases $1,000, on the average, for each $2,500 increase in operating capital; amounting to a substantial 40 percent return on operating capital. Of course, above average technology and managerial ability are assumed. The striking conclusion is that production loans, even at 7 percent interest, are a good investment for the efficient farmer.

Expansion in size of rented farm

Figure 8 presents optimum cropping plans for a rental operation efficiently expanding size in terms of acres and operating capital but restricted to the machinery complement III. Power equipment capacity for machinery group III has been expanded considerably beyond that for

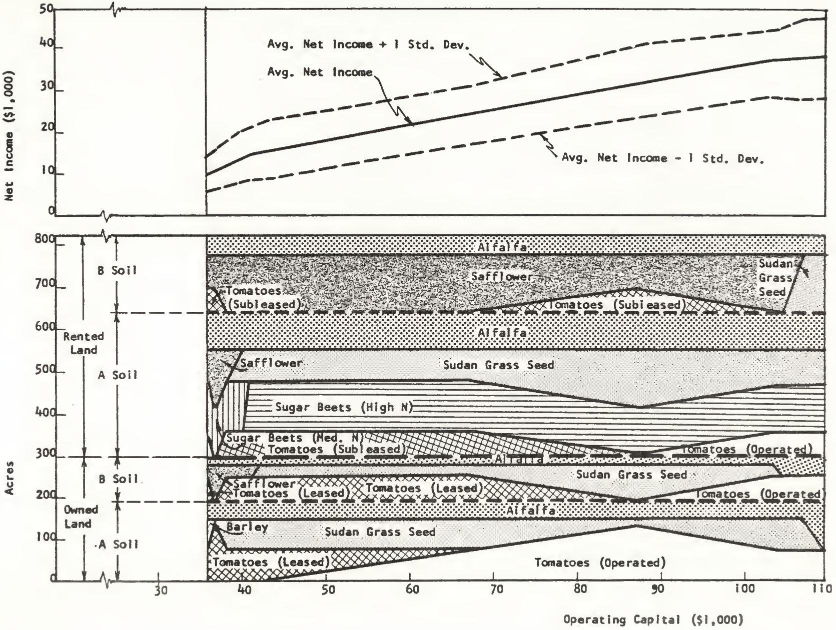
The [illegible] problem facing the operator in the [illegible] is the [illegible] allocation of [illegible] region [illegible] land in order to maximize profits [illegible] imposed by [illegible]. [illegible] the optimum patterns of [illegible] in terms of [illegible] levels of operating capital and [illegible]. Initially, [illegible] with [illegible] cropping [illegible]. [illegible] land while [illegible] part of [illegible] land [illegible] at the highest [illegible] the most profitable cropping system [illegible] per [illegible]. [illegible] levels. [illegible] planning.

The [illegible] for a [illegible] range from [illegible] (with [illegible] capital [illegible]) to a [illegible]. The [illegible] is nearly [illegible] levels of capital [illegible] increases [illegible]. The [illegible] capital [illegible] capital. [illegible] are [illegible]. [illegible] percent [illegible] the [illegible].

[illegible]

[illegible] size in terms of [illegible] and [illegible] capital [illegible] complementary [illegible]. [illegible]

Figure 7. Optimum Cropping Systems, Net Income and Net Income Variability for Combination Owned-Rented 820 Acre Farm.

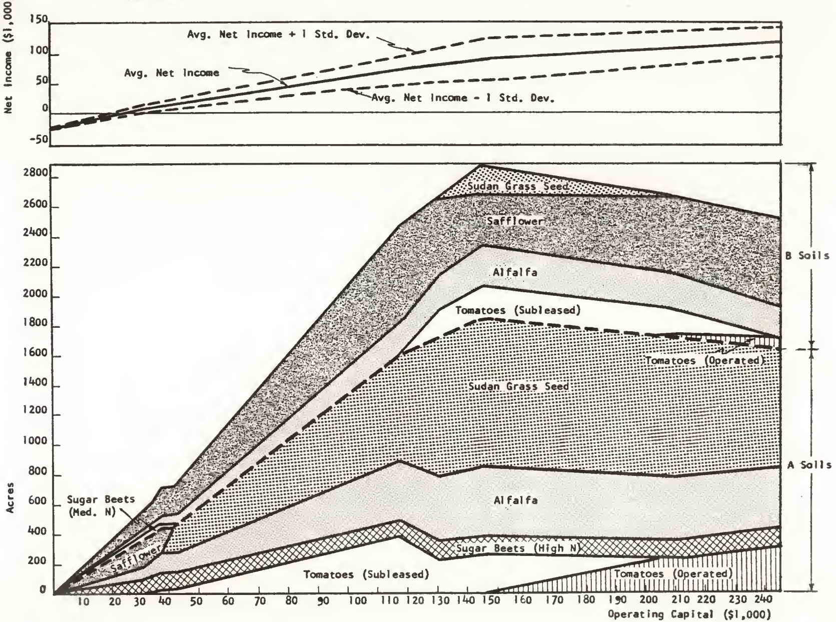


group I and II (see Table 1). As a result, rented land is expanded to a maximum of 2,870 acres before tracklayer capacity for field work in the months October through February limits further expansion in acreage. Wheel tractor time in May also becomes limiting, thus forcing intensification into higher value crops and contraction of rented land to 2,514 acres. Additional capital makes it profitable to reduce acreage rented and intensify the operation by growing tomatoes rather than sub-leasing. Thus, farmers operating with a relatively stable machinery complement can initially make most efficient use of machinery by expanding size (in acres); however, as machinery capacity is approached, they must reduce acreage with appropriate adjustments in the cropping program in order to further increase income.

Of course, as owned power equipment nears capacity, more profitable alternatives may be to extend capacity by contracting for additional tractor time or to purchase additional power units. The resulting farm plan would then emphasize further expansion in acreage and continuation of a less intensive cropping system. However, power equipment may not be readily available on a custom basis: few established custom tractor operators are available and the possibility of borrowing or renting equipment from neighbors is limited by the fact that critical operations on various farms tend to coincide. The possibility of purchasing additional equipment is probably more realistic in this area. Expansion possibilities with additional owned equipment are outlined later for machinery complement IV.

Net income in Figure 8 increases to $121,000, corresponding to an increase in working capital to $245,000. Again, production loans could be profitably employed to intensify the operation and make more efficient use of all resources. The variability boundaries around net income suggest that <u>absolute</u> risk increases at higher levels of income.

Figure 8. Optimum Cropping Systems, Net Income and Net Income Variability for Rented Farms Expanding Acreage (Machinery Size III).



However, <u>relative</u> to the level of income, the risk is no greater at higher income levels. In fact, the income variation as a percentage of income is actually less at high income levels.

Two points should be emphasized regarding the net income figures of Figure 8. First, the manager of a farm of the size typified at the upper range of acreage and capital level in Figure 8 would probably require at least one and perhaps two foremen to help manage and supervise the operation. In the study area, foremen of this caliber are paid \$6,000-8,000 a year. Many of the larger operations are also partnerships involving brothers, fathers and sons, etc. The income figures of Figure 8 should be adjusted downward to reflect wages paid either to foremen or to the operators themselves as supervisory wages. Second, the possibility of diseconomies of size should be recognized. Too little evidence is available to know whether diseconomies such as labor inefficiency, poor supervision of field work and irrigating, etc. do in fact increase appreciably with size. However, larger operators need to carefully guard against this possibility in order to preserve the level of incomes shown.

Farm Size IV

Combination owned-rented farm

The typical large farm in group IV contains 1,500 acres, with 300 acres owned and 1,200 acres share-rented. Owned and rented land are assumed available in 1:3 proportions of Yolo A and B soils, in contrast to the 2:1 assumption for smaller sizes. The farm survey information indicated that the 1:3 proportions are quite typical of the larger farms in the area. As the larger farms expand, it becomes more difficult to rent land only in the better soil areas and still keep the operation within manageable geographic bounds. Also, some larger farms prefer to

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rent heavier soils and concentrate more heavily on the lower risk highly mechanized grain crops.

Figure 9 presents profitable cropping systems and net income data at different levels of operating capital for the typical 1,500-acre operation. The familiar pattern of crop intensification with higher capital levels is again repeated. Details of the crop sequence shown in Figure 9 are not discussed except to point out the large acreage of alfalfa in the plan at the high capital level (1,031 acres of alfalfa at the capital level of $190,000). This shift to alfalfa relates to hay baling costs. In the group IV farm size, the operator typically owns his own baler (see Table 1) rather than employing a custom baler, thereby shifting part of the hay harvesting costs from the variable to the fixed category. As a consequence, net returns (gross income minus variable costs) per acre for alfalfa are favorable relative to competing crops.

With a 1,500-acre operation, Figure 9 shows that an annual net income of about $28,000 is possible, even when operating in the lower operating capital range of $65,000. At this capital level, the operator leases or subleases out his tomatoes, plants his sugar beet allotment and fills out the cropping system primarily with alfalfa and safflower. Thus, with a large farm of 1,500 acres, the operator can use a low intensive cropping system, avoid higher risk and minimize labor problems and still make a favorable income. While it can be shown that, on the average, a farmer in this position would improve his income considerably by intensifying his 1,500 acre operation, many farmers understandably prefer the lower income alternative. It is apparent that future increases in labor costs--not an unreasonable prospect--will affect income on the intensive operation more adversely than on the extensive farm. In the face of rising labor costs, only rapid mechanization of the high-labor crops would maintain the present income differentials. The effects

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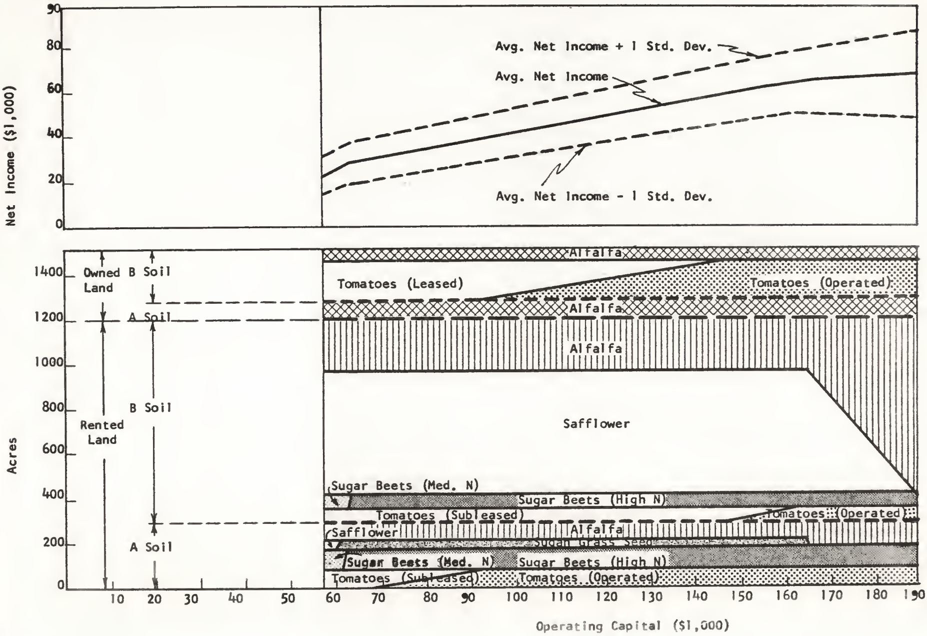
Figure 9. Optimum Cropping Systems, Net Income and Net Income Variability for a Combination Owned-Rented 1500 Acre Farm.



of wage increases on farm organizations are considered in a later section.

Expansion in size of rented farm

With machinery fixed at size IV (Table 1), output is expanded by renting under two alternative assumptions: (1) rented land is available in 2:1 proportions of Yolo A and B soils (the same proportions assumed for smaller sizes); (2) rented land is available in 1:3 proportions of Yolo A and B soils (more typical of the large farms).

Figures 10 and 11 summarize the cropping plans for the 2:1 and 1:3 soils situations, respectively. The plans for these two situations develop similarly, first concentrating on the crops providing high returns on limited capital. Beyond capital levels of about $130,000, machinery limitations in critical months require more intensive operation of a reduced acreage in order to profitably use additional operating capital. The major difference in the two situations is that safflower is the major "fill in" crop in Figure 11 (1:3 soils proportions) while sudan grass seed primarily serves this purpose in Figure 10 (2:1 soils proportions). However, since safflower is one of the few crops which produces higher yields on heavier soils, little reduction in income is observed in the situation where heavier soils predominate. In fact, the two soil situations summarized in Figures 10 and 11 are nearly identical in terms of net income and income variability. It thus appears that the necessity (or desire) to shift to heavier soils as farm size expands is not an important factor limiting expansion and income opportunities for farmers in the area, providing appropriate adjustments are made in the cropping system.

Questions are often raised concerning the relative profitability of farming intensively (using high levels of capital and other resources on limited acreage) versus farming extensively (combining the same resources

[illegible] farm organizations are considered in a later section.

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[illegible] (Table 1), [illegible] [illegible] (1) [illegible] of X and Y soils; [illegible] (2) [illegible] (3) [illegible] of X and Y soils [illegible].

Figures 10 and 11 [illegible], respectively. [illegible] capital levels of [illegible] [illegible] in order to [illegible]. The major differences in the two situations [illegible] in Figure 11 (1:1 soils proportions) [illegible] in Figure 10 (3:1 soils [illegible]). [illegible] on heavier soils, [illegible] in Figures 10 and 11 are [illegible] [illegible] [illegible] in [illegible] [illegible] [illegible].

Questions are often raised concerning the relative profitability of farming intensively (using high levels of capital and labor inputs on limited acreage) versus [illegible] extensively [illegible]

Figure 10. Optimum Cropping Systems, Net Income and Net Income Variability for Rented Farms Expanding Acreage (Machinery Size IV), Yolo A and Yolo B Soil in 2:1 Ratio.

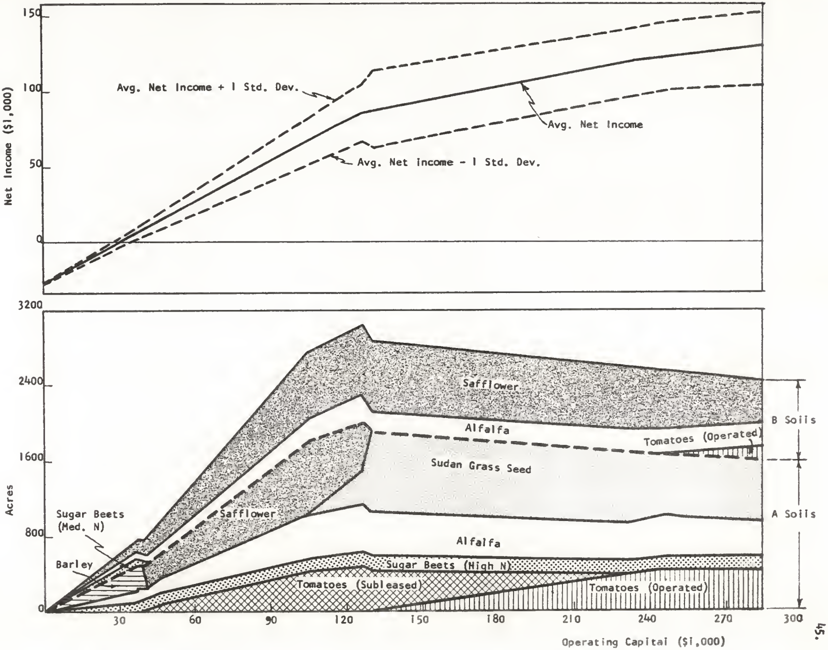
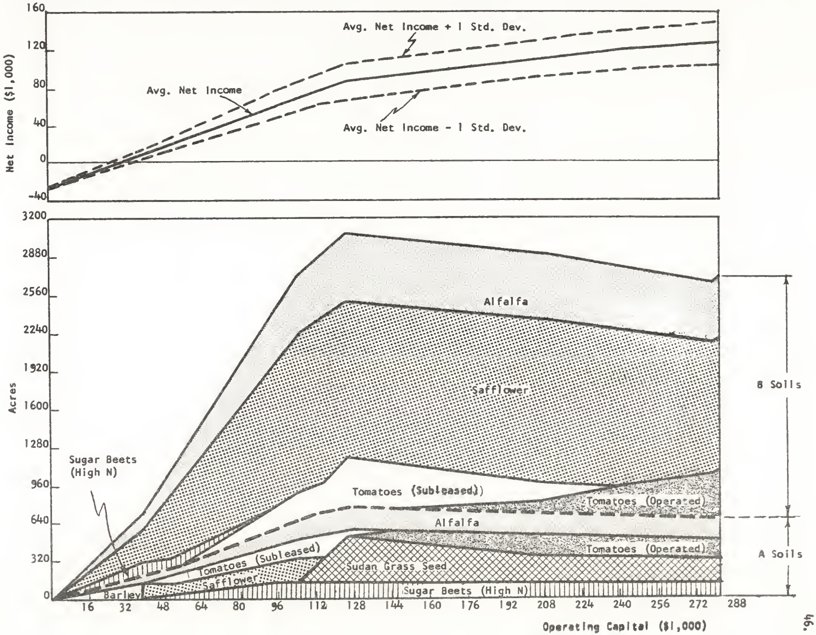


Figure 11. Optimum Cropping Systems, Net Income and Net Income Variability for Rented Farms Expanding Acreage (Machinery Size IV), Yolo A and Yolo B Soil in 1:3 Ratio.



with a larger acreage). Without exception this study indicates that, with given amounts of machinery and operating capital, higher income levels are possible by combining these resources with more land and farming less intensively. This principle can be illustrated by comparing Figures 9 and 11. Given machinery complement IV and approximately $128,000 in operating capital, the net income from the extensive operation (Figure 11 with 3,090 acres) is $83,000 while the net income from the intensive operation (Figure 9 with 1,500 acres) is only $52,000. Similar income differentials can be observed for other levels of operating capital in Figures 9 and 11.

Care is required in interpreting the net income figures in Figures 10 and 11, particularly in the upper range. As mentioned before, the salaries ($6,000-8,000 each) of one and possibly two foremen probably should be deducted. Interest charges on borrowed capital (which could easily total $8,000-10,000) should also be deducted to arrive at the appropriate net farm income to the owner-operator. Furthermore, and perhaps more important, full understanding of the underlying assumptions of normal yields, prices and costs is necessary. The managerial burden increases greatly in the upper range, perhaps making normal yields and cost difficult to attain regularly. Some large operators in the area expressed concern about lack of proper labor supervision, particularly in irrigating and tractor operations, as size increased. The increasing size and complexity of the operation also increases problems of timing and co-ordination of operations. These problems rest squarely with the manager and his foremen--whether they avoid various types of "slippage" and "red tape" will determine to a large extent the success of the operation. Thus, the net income figures shown are only indications of the level possible under normal conditions assuming efficient operation. Considering the importance of the management factor, particularly in the larger operations, the variability or risk ranges shown are probably too narrow.

Also, as farms expand to the upper range in size, legal and tax problems gain greater importance. Many farmers in the Woodland area rely almost entirely on accountants for record keeping and tax work. The possibility of incorporation or other changes in farm business control to reduce personal liability and taxes suggests the increased importance of legal assistance for larger farmers. Fees for these and other specialists and consultants possibly increase more than proportionately with size, reducing the income of the large farms. In any case, despite the apparent income advantages of the larger farms in this study, relatively few farms in the area have expanded beyond 1,500 acres in size.

While the net income figures in Figures 10 and 11 appear quite high, it should be recognized that the operator is owner-manager of a firm with sales of nearly one-half million dollars, operating capital of nearly \$300,000 and average investment in machinery alone of nearly \$100,000. It is not surprising that an efficient owner-manager of an enterprise of this size, complexity and risk is well rewarded under normal price and yield conditions.

Stability of Most-Profitable Cropping Systems

A measure of income variability (average net income $\pm$ one standard deviation) has been provided for each cropping system in this study. For a given cropping system, this measure indicates the variability in net income from fluctuations in prices, yields and costs. A related but separate question is: How stable is the cropping system itself? For example, how much can prices, yields or labor costs vary before a different cropping system becomes more profitable? It would be difficult

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to investigate these questions for each individual cropping system in this report. However, examples from a typical 480-acre farm situation (Farm Size II) are provided below as illustrative of the general nature of results obtained.

Effects of increasing wage rates

The effects of increased wage rates on the cropping system and on net incomes are examined first. At lower capital levels and present wage rates, the cropping systems emphasize crops with a high return per dollar of operating capital and low labor inputs (see Figures 4 and 5). Therefore, increases in the wage rate would influence the cropping systems and net incomes relatively little. However, plans at high capital levels contain substantial acreages of the higher value, more labor-intensive crops (tomatoes, sugar beets and alfalfa) and are, therefore, influenced to a greater extent by rising labor costs. At present wages ($1.50 per hour for machinery operation and $1.15 per hour for hand labor) the owned 480-acre farm plan with maximum operating capital (Figure 4) contains only tomatoes, sugar beets and alfalfa. This plan is optimum until wages are increased by about 10%. At this wage level, sudan grass seed replaces alfalfa, leaving only the minimum alfalfa acreage required for rotation purposes. The cropping plan then remains constant until wages increase by about 50%; at this point tomatoes are dropped from the optimum plan. Net farm income is reduced sharply by the 50% wage increase, dropping from $18,000 at present wages to $-2,000. Further increases in wages beyond 50% would change plans very little; in fact, the wage rate could triple before sugar beets drop from the most profitable cropping system. Of course, net farm income would continue to drop steadily.

In the rented 480-acre situation, a wage rate increase of only about 30% would force tomatoes from the most profitable renter cropping

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system.[1/] Accompanying this shift would be a drop in net income from $16,200 to $8,500. An increase in the wage rate to 50% would not change the plan further but would force net income down to about $6,200. In summary, under the assumptions of this study, a 50% wage increase would force both owners and renters out of tomatoes. However, the income reduction would be more pronounced for the owner.

Effects of changing yields and crop prices

Changes in product prices or yields per acre influence cropping systems and incomes as follows: When capital is limited and the cropping system consists primarily of grain crops and alfalfa, relatively small changes in product prices and yields among these crops could alter the most profitable cropping system. Since resource requirements among many of these crops are very similar, simple budgets provide a good guide to the most profitable crop in particular price and yield situations. However, when capital is ample and sugar beets and tomatoes enter the plan, more drastic price and yield changes are required to shift the optimum plan. For the 480-acre owner-operated situation, tomatoes would remain in the most-profitable cropping system until tomato prices dropped to $17 per ton (yields remaining constant) or yields dropped to about 15 tons (prices remaining constant). Similarly, sugar beets would remain in the optimum plan until prices dropped to about $8.50 per ton or yields dropped to about 16 tons. Of course, lesser decreases in yields and prices simultaneously would force tomatoes and sugar beets from the optimum plan.

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1/ It appears reasonable to expect that increasing wages would, in time, alter the share rental agreement to reflect the increased portion of total costs borne by the renter. In this case, high value-high labor crops would not be "forced" out of the most profitable plan until higher percentage increases were realized.

The 480-renter situation is somewhat more sensitive to price and yield changes. In this case, tomatoes drop from the optimum plan when prices fall below $18.50 per ton or yields fall below about 17 tons; sugar beets remain in the plan until prices drop below about $9 per ton or yields below about 17 tons.

In summary, rather modest wage increases might prevent tomatoes from entering optimum cropping systems, particularly in view of the risks associated with tomato production. However, sugar beets would remain in Yolo County cropping systems under any foreseeable wage increase. Both tomatoes and sugar beets have considerably higher net incomes per acre than alternative crops (Appendix tables A-1 and A-2). Hence, substantial decreases in yields and/or prices would be required to make alternative crops more profitable. Again, however, the relatively higher risk associated with tomatoes (Appendix tables B-1 and B-2) might induce growers to shift away from tomato production with somewhat lesser yield and price decreases. It should be emphasized that the above results are based on the specific assumptions of this study and on particular size and tenure situations. However, the results should be indicative of results obtained in other Yolo County situations.

APPENDIX A

DETAILED COSTS, RETURNS AND INPUT-OUTPUT INFORMATION

TABLE A-1

Summary of Owner-Operator Variable Costs and Returns Per Acre for Each Crop Alternative, by Machinery Size Group

Crop	Soil a/	Fertilizer b/ level	Machinery Size I			Machinery Size II			Machinery Size III			Machinery Size IV		
			Gross ret. per acre c/	Var. cost per acre d/	Net ret. per acre e/	Gross ret. per acre c/	Var. cost per acre d/	Net ret. per acre e/	Gross ret. per acre c/	Var. cost per acre d/	Net ret. per acre e/	Gross ret. per acre c/	Var. cost per acre d/	Net ret. per acre e/
			dollars											
Tomatoes (operated)	A	med.	440	280	160	440	279	161	440	277	163	440	276	164
		high	528	331	197	528	330	198	528	328	200	528	327	201
	B	med.	418	271	147	418	270	148	418	268	150	418	267	151
		high	506	323	183	506	321	185	506	320	186	506	318	188
Tomatoes (leased out)	A	high	79	0	79	79	0	79	79	0	79	79	0	79
	B	high	76	0	76	76	0	76	76	0	76	76	0	76
Sugar beets	A	low	235	123	112	235	104	131	223	81	142	223	80	143
		med.	298	149	149	298	122	176	283	99	184	283	98	185
		high	325	168	157	325	134	191	309	112	197	309	110	199
	B	low	221	123	98	221	104	117	210	81	129	210	80	130
		med.	280	149	131	280	122	158	266	99	167	266	98	168
		high	305	168	137	305	134	171	290	112	178	290	110	180
Alfalfa hay	A	-	165	83	82	165	83	82	165	82	83	165	71	94
	B	-	143	78	65	143	78	65	143	77	66	143	69	74
Pink beans	A	-	143	74	69	143	73	70	143	71	72	143	71	72
	B	-	117	72	45	117	71	46	117	68	49	117	69	48
Alfalfa seed	A	-	157	90	67	157	90	67	157	90	67	157	90	67
	B	-	130	90	40	130	90	40	130	90	40	130	90	40
Safflower	A	-	68	26	42	67	25	42	68	25	43	68	25	43
	B	-	75	26	49	75	25	50	75	25	50	75	25	50
Barley	A	-	68	22	46	68	20	48	68	21	47	68	20	48
	B	-	56	22	34	56	20	36	56	21	35	56	20	36
Wheat	A	-	90	24	66	90	23	67	90	23	67	90	23	67
	B	-	72	23	49	72	22	50	72	22	50	72	21	51
Milo	A	-	105	48	57	105	47	58	105	48	57	105	47	58
	B	-	84	48	36	84	47	37	84	48	36	84	47	37
Corn	A	-	162	107	55	162	106	56	162	106	56	162	106	56
	B	-	138	94	44	138	94	44	138	94	44	138	94	44
Sudan grass seed	A	-	130	51	79	130	50	80	130	51	79	130	50	80
	B	-	110	49	61	110	48	62	110	48	62	110	48	62

(Continued on next page)

Table A-1 continued:

a/ A refers to Yolo A soils (Yolo fine sandy loams, silt loams and loams); B refers to Yolo B soils (Yolo clay loams and clays).

b/ Refer to Table 2 for fertilizer and yield assumptions.

c/ Gross return equals yield (Table 2) times price (Table 3).

d/ "Variable cost" includes labor (at $1.50 per hour for tractor driving, $1.10 per hour for irrigation and unskilled labor), fuel, oil, seed, fertilizer and other direct production expenses. Does not include any "fixed costs" such as depreciation or interest.

e/ Net return = gross return - variable cost. Fixed costs have not been subtracted.

TABLE A-2

Summary of Tenant Variable Costs and Returns Per Acre for Each Crop Alternative, by Machinery Size Group

Crop	Soil a/	Fertilizer b/ level	Machinery Size I: Gross ret. per c/ acre	Machinery Size I: Var. cost per d/ acre	Machinery Size I: Net ret. per e/ acre	Machinery Size II: Gross ret. per c/ acre	Machinery Size II: Var. cost per d/ acre	Machinery Size II: Net ret. per e/ acre	Machinery Size III: Gross ret. per c/ acre	Machinery Size III: Var. cost per d/ acre	Machinery Size III: Net ret. per e/ acre	Machinery Size IV: Gross ret. per c/ acre	Machinery Size IV: Var. cost per d/ acre	Machinery Size IV: Net ret. per e/ acre
			dollars											
Tomatoes (operated)	A	med.	374	280	94	374	279	95	374	277	97	374	276	98
		high	449	331	118	449	330	119	449	328	121	449	327	122
	B	med.	355	271	84	355	270	85	355	268	87	355	267	88
		high	430	323	107	430	321	109	430	320	110	430	318	112
Tomatoes (subleased out)	A	high	13	9	4	13	9	4	13	9	4	13	9	4
	B	high	13	9	4	13	9	4	13	9	4	13	9	4
Sugar beets	A	low	188	123	65	188	104	84	178	81	97	178	80	98
		med.	238	149	89	238	122	116	227	99	128	227	98	129
		high	260	168	92	260	134	126	247	112	135	247	110	137
	B	low	177	123	54	177	104	73	168	81	87	168	80	88
		med.	224	149	75	224	122	102	213	99	114	213	98	115
		high	244	168	76	244	134	110	232	112	120	232	110	122
Alfalfa hay	A	-	124	83	41	124	83	41	124	82	42	124	71	53
	B	-	107	78	29	107	78	29	107	77	30	107	69	38
Pink beans	A	-	107	74	33	107	73	34	107	71	36	107	71	36
	B	-	88	72	16	88	71	17	88	68	20	88	69	19
Alfalfa seed	A	-	118	90	28	118	90	28	118	90	28	118	90	28
	B	-	98	90	8	98	90	8	98	90	8	98	90	8
Safflower	A	-	51	26	25	51	25	26	51	25	26	51	25	26
	B	-	56	26	30	56	25	31	56	25	31	56	25	31
Barley	A	-	41	22	19	41	20	21	41	21	20	41	20	21
	B	-	34	22	12	34	20	14	34	21	13	34	20	14
Wheat	A	-	54	24	30	54	23	31	54	23	31	53	23	31
	B	-	43	23	20	43	22	21	43	22	21	43	21	22
Milo	A	-	79	48	31	79	47	32	79	48	31	79	47	32
	B	-	63	48	15	63	47	16	63	48	15	63	47	16
Corn	A	-	122	107	15	122	106	16	122	106	16	122	106	16
	B	-	103	94	9	103	94	9	103	94	9	103	94	9
Sudan grass seed	A	-	98	51	47	98	50	48	98	50	48	98	50	48
	B	-	82	49	33	82	48	34	82	48	34	82	48	34

(Continued on next page)

TABLE [illegible]

Summary of [illegible] Variable Costs and Returns Per Acre for Each Area [illegible], by [illegible] Area [illegible]

[illegible]

Table A-2 continued:

a/ A refers to Yolo A soils (Yolo fine sandy loams, silt loams and loams); B refers to Yolo B soils (Yolo clay loams and clays).

b/ Refer to Table 2 for fertilizer and yield assumptions.

c/ Gross return equals yield (Table 2) x price (Table 3) x tenant's share (Table A-5).

d/ "Variable cost" includes labor (at $1.50 per hour for tractor driving, $1.10 per hour for irrigation and unskilled labor), fuel, oil, seed, fertilizer and other direct production expenses. Does not include any "fixed costs" such as depreciation or interest.

e/ Net return = gross return - variable cost. Fixed costs have not been subtracted.

TABLE A-3

Fixed Costs for Each Major Resource Situation Analyzed

Situation analyzed in text					
Machinery size group	Tenure	Acres operated	Machinery fixed costs a/	Land fixed costs b/	Total farm fixed costs c/
I	owned	225 acres	$11,172	$12,600	$23,772
	rented	225 acres	11,172	0	11,172
	expanded by renting	variable	11,172	0	11,172
II	owned	480 acres	14,101	26,880	40,981
	rented	480 acres	14,101	0	14,101
	expanded by renting	variable	14,101	0	14,101
III	owned-rented	300 acres owned-- 520 acres rented	19,747	16,800	36,547
	expanded by renting	variable	19,747	0	19,747
IV	owned rented	300 acres owned-- 1200 acres rented	31,833	16,800	48,633
	expanded by renting (2:1 soils)	variable	31,833	0	31,833
	expanded by renting (1:3 soils)	variable	31,833	0	31,833

a/ Machinery fixed costs include annual depreciation, 6% interest on the average investment, taxes, insurance and the "fixed" portion of repair costs.

b/ Land fixed costs are $56 per acre, computed as 6% return on $800 per acre land ($48) plus $8 per acre land tax. Fixed costs for irrigation system included in land fixed costs.

c/ Total farm fixed costs = machinery fixed costs + land fixed costs.

TABLE A-4

Tracklayer and Wheel Tractor Power Availability and Per Acre Crop Requirements, by Time Periods a/

Farm size, equipment and time period	Per acre power requirements, by crops and time periods b/											Power available			
	To-mato	Sugar beets	Alfalfa hay	Pink beans	Alfalfa seed	Saf-flower	Barley	Wheat	Milo	Field corn	Sudan seed	Days avail-able for c/ fld. wrk.	Tot. hrs. per tractor avail-able d/	Number of tractors	Total tractor hours avail-able
SIZE I															
Tracklayer														2	
Sept.1-Oct.15	-	-	0.80	-	0.80	-	1.12	1.12	-	-	-	44	440		880
Oct.16-Feb.15	3.6	5.2	0.25	.7	0.25	1.5	.38	.38	.16	.32	.2	74	740		1480
Feb.16-May 1	-	-	-	3.4	-	-	-	-	.84	1.68	1.0	51	510		1020
Wheel tractor														2	
Sept.1-Oct.30	-	-	1.0	.4	1.0	-	-	-	-	-	-	59	590		1180
Nov.1-Feb.1	-	-	0	-	0	-	.5	.8	-	-	-	53	530		1060
Feb.1-Apr.1	1.7	1.2	-	-	-	.8	-	-	.4	-	-	34	340		680
Apr.1-30	-	.8	-	1.0	-	-	.2	-	.4	-	.3	24	240		480
May 1-31	.5	-	.7	.5	.7	-	.2	-	.25	.5	.3	29	290		580
June 1-30	.5	.4	.7	.8	-	-	-	-	.47	.17	-	30	300		600
July 1-31	.5	.4	.7	.8	-	-	-	-	.47	.17	-	31	310		620
Aug. 1-31	.5	-	.7	-	-	-	-	-	.27	.17	-	31	310		620
SIZE II															
Tracklayer														2	
Sept.1-Oct.15	-	-	0.80	-	0.80	-	.9	1.0	-	-	-	44	440		880
Oct.16-Feb.15	2.9	4.4	0.25	.57	0.25	1.3	.3	.3	.13	.3	.17	74	740		1480
Feb.16-May 1	-	-	-	2.83	-	-	-	-	.67	1.5	.83	51	510		1020
Wheel tractor														2	
Sept.1-Oct.30	-	2.0	1.0	.4	1.0	-	-	-	-	-	-	59	590		1180
Nov.1-Feb.1	-	-	0	-	0	-	.4	.6	-	-	-	53	530		1060
Feb.1-Apr.1	1.3	1.0	-	-	-	.6	-	-	.4	-	-	34	340		680
Apr.1-30	-	.7	-	.9	-	-	.17	-	.4	-	.2	24	240		480
May 1-31	.5	-	.7	.5	.7	-	.17	-	.25	.5	.3	29	290		580
June 1-30	.5	.4	.7	.8	-	-	-	-	.45	.17	-	30	300		600
July 1-31	.5	.4	.7	.8	-	-	-	-	.44	.17	-	31	310		620
Aug. 1-31	.5	1.0	.7	-	-	-	-	-	.27	.17	-	31	310		620

(Continued)

Table A-4 Continued

Farm size, equipment and time period	Per acre power requirements, by crops and time periods b/											Power available			
	To-mato	Sugar beets	Alfalfa hay	Pink beans	Alfalfa hay	Saf-flower	Barley	Wheat	Milo	Field corn	Sudan seed	Days avail-able for fld. wrk. c/	Tot. hrs. per tractor avail-able d/	Number of tractors	Total tractor hours avail-able
SIZE III															
Tracklayer														3	
Sept.1-Oct.15	-	-	0.50	-	0.50	-	.9	.85	-	-	-	44	440		1320
Oct.16-Feb.15	2.5	3.2	.15	.43	.15	1.1	.3	.25	.13	.22	.17	74	740		2220
Feb.16-May 1	-	-	-	2.17	-	-	-	-	.67	1.08	.83	51	510		1530
Wheel tractor														3	
Sept.1-Oct.30	-	1.1	.84	.4	.84	-	-	-	-	-	-	59	590		1770
Nov.1-Feb.1	-	-	0	-	0	-	.4	.6	-	-	-	53	530		1590
Feb.1-Apr.1	1.2	1.2	-	-	-	.6	-	-	.4	-	-	34	340		1020
Apr.1-30	-	.8	-	.8	-	-	.15	-	.4	-	.2	24	240		720
May 1-31	.5	-	.7	.5	.7	-	.15	-	.25	.5	.3	29	290		870
June 1-30	.5	.4	.7	.8	-	-	-	-	.42	.17	-	30	300		900
July 1-31	.5	.4	.7	.8	-	-	-	-	.42	.17	-	31	310		930
Aug.1-31	.5	.6	.7	-	-	-	-	-	.27	.17	-	31	310		930
SIZE IV															
Tracklayer														4	
Sept.1-Oct.15	-	-	0.50	-	0.50	-	.68	.82	-	-	-	44	440		1760
Oct.16-Feb.15	2.0	2.8	.15	.38	.15	1.1	.22	.28	.1	.22	.13	74	740		2960
Feb.16-May 1	-	-	-	1.92	-	-	-	-	.5	1.08	.67	51	510		2040
Wheel tractor														6	
Sept.1-Oct.30	-	1.1	2.25	.4	2.25	-	-	-	-	-	-	59	590		3540
Nov.1-Feb.1	-	-	0	-	0	-	.3	.4	-	-	-	53	530		3180
Feb.1-Apr.1	1.1	.75	-	-	-	.4	-	-	.4	-	-	34	340		2040
Apr.1-30	-	.55	-	.8	-	-	.14	-	.4	-	.15	24	240		1440
May 1-31	.5	-	2.1	.5	2.1	-	.14	-	.25	.5	.30	29	290		1740
June 1-30	.5	.4	2.1	.8	-	-	-	-	.41	.17	-	30	300		1800
July 1-31	.5	.4	2.1	.8	-	-	-	-	.41	.17	-	31	310		1860
Aug. 1-31	.5	.6	2.1	-	-	-	-	-	.27	.17	-	31	310		1860

a/ A. D. Reed and P. S. Parsons, Farm Management Extension Specialists, University of California, Davis, assisted in estimating time periods for individual field operations for each crop.

b/ Based on numerous California Extension Service publications pertaining to different crops. Calculated on an engineering efficiency basis.

c/ Total days available minus the Yolo County 15-yr. average no. of days not available for field work due to rain.

d/ Based on a 10-hr. day.

TABLE A-5

Most Common Leasing Arrangements, Yolo County Area

Crop	Share to landlord a/	Cash rent	Shares used in programming b/
Tomatoes	15-20%	($60-80)	15%
Sugar beets	20%		20%
Alfalfa	25% (Roadside)		25% (Roadside)
Pink beans (single crop)	20-25%		25%
Safflower	25-30%		25%
Barley	25-40%		40%
Wheat	25-40%		40%
Milo (single crop)	25%		25%
Corn	25%		25%
Sudan grass seed	25%		25%
Alfalfa seed	25%		25%

a/ Based on 1959 survey of 37 Yolo County farmers and on: Sample Costs of Production; Equipment Charges and Cost Estimates of Selected Crops, Yolo County, 1958, Calif. Agr. Ext. Serv., Woodland, California, 1958.

b/ Assumes that landlord does no field work; tenant pays electricity for pumping.

APPENDIX B

INCOME VARIABILITY DATA

TABLE B-1

Net Income Standard Deviations of Individual Crops and Net Income Correlations Between Yolo County Crops (for owner-operated). a/

Crop b/	Net income standard deviation per acre	Crop: Tomatoes (Operated)	Tomatoes (leased out)	Sugar beets	Alfalfa hay	Barley	Wheat	Sudan grass seed	Safflower
	dollars/acre	net income correlations between crops							
Tomatoes (operated)	29	1.00	.93	-.04	0.60	0.16	-0.43	-0.28	0.39
Tomatoes (leased out)	6		1.00	0.03	0.56	0.10	-0.43	-0.22	0.45
Sugar beets	18			1.00	-0.37	-0.05	0.28	-0.15	0.10
Alfalfa hay	16				1.00	0.42	-0.36	0.33	0.26
Barley	6					1.00	0.60	0.39	-0.70
Wheat	7						1.00	0.22	-0.31
Sudan grass seed	29							1.00	-0.01
Safflower	8								1.00

a/ The net income standard deviations and correlations in this table are calculated using the variate difference method. See: Tintner, Gerhard, The Variate Difference Method, Bloomington, Ind.: Principia Press, Inc., 1940. (Cowles Commission for Research in Economics, Monograph No. 5). For an application of this method, see: Dean, G. W., and H. O. Carter, "Measurement of Enterprise Variability by the Variate Difference Method," Agricultural Economics Research, Vol. XII, No. 2, April, 1960.

b/ Although other crops were considered in the study, the list here includes only those which entered the optimum plans presented.

TABLE B-2

Net Income Standard Deviations of Individual Crops and Net Income Correlations Between Yolo County Crops (for Tenant). a/

Crop b/	Net income standard deviation per acre	Crop: Tomatoes (operated)	Tomatoes (subleased out)	Sugar beets	Alfalfa hay	Safflower	Barley	Sudan grass seed
	dollars/acre		net income correlations between crops					
Tomatoes (operated)	24	1.00	0	-0.04	0.63	0.35	0.14	-0.04
Tomatoes (subleased out)	0		1.00	0	0	0	0	0
Sugar beets	14			1.00	-0.40	0.31	-0.04	-0.16
Alfalfa hay	12				1.00	0.24	0.38	0.29
Safflower	6					1.00	-0.73	-0.03
Barley	3						1.00	0.42
Sudan grass seed	21							1.00

a/ See footnote a/, Table B-1.

b/ See footnote b/, Table B-1.